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THE BRITISH ASSOCIATION

DR. W. E. SWINTON was well entitled to claim, in his presidential address to Section X (Assembly of Corresponding Societies) of the British Association meeting at Liverpool, that he had entered the gateway which Sir Edward Appleton had held open in his presidential address to the Association on the previous evening. Dr. Swinton's address essentially was an exploration or review of the ways in which the corresponding societies, individually and in concert, can further the pursuit of science for its own sake and the consequent enrichment of the life of the community, to which Sir Edward had referred. In this, moreover, Dr. Swinton was following the example of some of his predecessors in the presidential chair of the Conference of Delegates of Corresponding Societies, since the Conference was first constituted at the Aberdeen meeting of the Association in 1885.

Particularly in the opening years of this century, the Conference was concerned with the possibility of strengthening the work of the corresponding societies and with the opportunities for scientific work which were still presented to them in certain fields. Prof. (later Sir) Ray Lankester's reference, in his presidential address to the Association at Bradford in 1900, to the decline in the numbers and activities of the field naturalists led to various suggestions when the Conference next met in 1901, at Glasgow, and a resolution was adopted by the Conference at Southport in 1903, supporting the suggestion made by Sir Norman Lockyer in his famous address, "The Influence of Brain-Power on History", that scientific workers and persons interested in science be so organized that they may exert permanent influence on public opinion, in order more effectively to carry out the third object of the Association—"to obtain a more general attention to the objects of science and the removal of any disadvantages of a public kind which impede its progress".

Sir Norman Lockyer's suggestion led directly to the formation of the British Science Guild; but the Conference continued to concern itself with the possibilities and opportunities for local work and for influencing local opinion in matters affecting science. At Dublin, in 1908, Prof. (later Sir) Henry Miers addressed the Conference on the educational opportunities of local scientific societies and their contribution to adult education, and adult education was the theme of Dr. F. A. Butler's presidential address to the Conference at Burlington House in 1918. Sir John Russell's address to the Conference at Oxford in 1926 is notable for the encouragement it gave alike to the amateur worker and to the local scientific society; and the present constitution of the Assembly, now one year old, affords even better opportunities for fulfilling the continuing functions of systematic observation and of co-operation, whether in the organization of work or in the exposition of science.

What is new about Dr. Swinton's address, accordingly, is not so much his conception of the work of the corresponding societies as his critical re-examina-

tion of the functions of both the Association and of the Assembly and its constituent societies in the light of the environment and the climate of opinion in which they are set to-day. He is conscious not only of the deepened sense of public responsibility on the part of men of science, of the wide public interest displayed in the annual meetings of the British Association, and the steps which have already been taken, in the new series of lectures for younger persons, for example, to extend the influence of the Association in making known the advances of science and their implications. He is conscious, also, of the great change in the educational background which has taken place since the Conference of Corresponding Societies was constituted.

The circumstances are changing, rather than new; but when contrasted with those of even a quarter of a century ago, they show differences sufficiently marked to justify fully Dr. Swinton's plea that the work of the Sections and of the Assembly should be reconsidered in the light of present opportunities and responsibilities, and with the view of furthering a more lasting interest in certain aspects of science than can be engendered during the annual meeting. Dr. Swinton points out that the fundamental idea of the Association as a body for explaining the trends of science generally finds expression only in the presidential address and in a few other meetings such as the evening discourses or those arranged by the Division for Social and International Relations of Science. Some of the joint meetings of the Sections, even on highly technical subjects, have attracted large audiences, and the level of exposition has on occasion been high, even from a popular point of view. This cannot be said of all joint discussions, however. Nevertheless, there is some substance in Dr. Swinton's argument that, however wide the appeal of the presidential address, the programmes of the sections tend to become more specialized.

The fact that others have, since the Liverpool meeting, suggested that the British Association may need to take account of two differing audiences—the general public and the specialists who form the nucleus of the sectional meetings—indicates that this may be an appropriate time for the Association to reconsider its functions and the audiences which it is addressing. Nor should it be forgotten that while, as Dr. Swinton rightly argues, the advance of science is so rapid and the increase of workers so considerable that a week is too short a period for the workers in one group to learn about the recent advances of their fellows, the sections fulfil another and possibly more important function. Disregarding for the moment the question whether, seen against the background of scientific meetings which take place throughout the year, the sectional meetings are the appropriate occasion for the communication of results from one specialist to another, the sectional meetings undoubtedly are an important means for interchanging knowledge across the scientific disciplines. In all sectional meetings a considerable proportion of the scientists present are now those trained in or practising some other discipline than that of the particular section holding the meeting. Quite possibly to an increasing extent the British Association meeting now provides an outstanding opportunity for the scientist attending it to learn about or discuss advances or trends in some discipline other than that with which he is immediately concerned.

This tendency is certainly sufficiently pronounced to require more consideration than some sections at present appear to give it. In facilitating such interdisciplinary exchanges as well as in the arrangement of discussions on subjects which are the concern of several scientific disciplines, the Association is performing one of its most valuable services to science to-day, and this function should not be overlooked in considering Dr. Swinton's call to the Assembly of Corresponding Societies to take up the function of accountant for science. He suggests that that Assembly is particularly suited to render a public account of the progress of science and provide an annual forum for questions and even answers. The meetings of the Assembly are no longer confined to delegates of the Societies but are open to any who care to attend. They are also more numerous, and on both counts the Assembly is better placed to discharge the responsibility taken over from the former Conference of Delegates to discuss propositions regarding the promotion of more systematic observations and plans of operation and of greater uniformity in the method of publishing results.

It is in this context that Dr. Swinton examined the question of how far the Assembly can help inquirers for scientific information not only during the local opportunities of the meeting, but also on a more permanent and wider basis, and he was concerned not simply with the diffusion of scientific knowledge or information but equally with helping people, both young and old, to engage in scientific work whether for pleasure or as professional occupation. On both counts regard must be had to the general educational position in Britain, and while he suggested that the Assembly's main task would lie in the field of adult education, he indicated the need for some further inquiry into the position of the scientific societies, more especially the local societies, the reasons for their diminishing membership and their general difficulties of publication and the like. Such inquiry involves also inquiry into the teaching of science in schools and whether such teaching really stimulates interest in science either for its own sake or as a career. That can have a close bearing on the shortage of science teachers and of technologists, for example: as Sir Charles Morris remarked at the recent Headmasters' Conference, the firing of imagination which determines careers is often the work of a teacher.

Dr. Swinton's own more specific suggestions were in regard to adult education, and especially for closer co-operation between those three major avenues of adult or self-education—the museums, the public libraries and the local scientific societies. Such co-operation must be conceived in the light of the education system of to-day, and the research committee which he advocated would, in the first instance, co-operate with the Library Association, the Museums Association, the Unions of Scientific Societies, the

Further Education Section of the B.B.C. and such of the local educational authorities as could be interested. He also advocated a series of booklets giving the outline of educational courses in the sciences, of sources of information for adults, and a guide for young people as to ways of entering the professions.

The whole programme of the Assembly of Corresponding Societies at Liverpool was well designed to test and to explore these suggestions. Dr. P. M. Butler's paper on trends in natural history in the north-west of England was concerned with the new functions of the local scientific societies and with the ways in which they could to-day best help the amateur naturalists who are carrying on the work of those earlier naturalists of Lancashire, mainly botanists, and particularly around Manchester and Oldham, who in the first half of the nineteenth century had won an international reputation especially in the study of mosses. Mr. R. Wagstaffe, in speaking on "Natural History: the Amateur and the Professional", dealt principally with the functions of the museums, but indicated the extent to which the natural history departments of museums rely on the help of amateurs in securing material. The co-operation between amateur and professional, for which he pleaded, indicates one line of work which could be very fruitfully followed by the Assembly and its constituent societies.

That also applies to the question of publication, to which Mr. Wagstaffe referred very briefly, noting the difficulty which the small societies experience in financing the publication of their research results. The museum botanist and the community was the subject of a further paper by Mr. H. Stansfield. It is thus clear that this year's Assembly made a fair start on the consideration of how it and its constituent societies can best help those anxious to pursue science for its own sake and also foster a wider interest in and understanding of plant and animal life by the community. Two sessions were given to the consideration of practical problems of animal health and welfare and the protection of Nature, in which also public understanding is both desirable and often an essential condition for a satisfactory solution.

The session devoted to the presentation of science was, however, much more closely concerned with Dr. Swinton's suggestions and with the theme of Sir Edward Appleton's presidential address, as well as with the comments which he made at the close of the Liverpool meetings, when he stressed the importance of using simple language and ordinary words in public exposition. Dr. D. A. Allan was concerned with the museum presentation of science and the possibilities which such techniques afford of presenting scientific material and the development of scientific ideas. He recognized the tendency of museums to divide science into water-tight compartments, but the functions of the museum in adult or self-education are limited by the standard of public education and especially by the quality of the teaching of science in schools.

Mr. E. Yerbury's paper dealing with this topic was undoubtedly the key paper in this discussion. He thinks that in the schools science should be presented more as a means of service to the community, as a way of finding things out. It should be presented as an activity demanding discipline; for the child under fourteen, breadth rather than depth is important, and the content of science teaching should be related to the child's environment. For this reason he suggested that biology and general science, rather than the physical sciences, should form the approach and main content in school science. Referring to the shortage of science teachers, he stressed the importance of a sympathetic public, especially if science teachers of high character as well as ability are to be attracted.

Mr. Yerbury's address went to the root of the matter and indicated some ways in which the Assembly of Corresponding Societies can help to improve the situation. His constructive address contrasted sharply with the somewhat provocative address on the presentation of science to the public from Mr. Ritchie Calder which followed. Much of Mr. Calder's criticism of scientists as expositors, such as their failure to break through their own special or professional jargon when attempting to communicate ideas, their indifference to expressing themselves intelligibly, and their irresponsible refusal to consider and explain how their work affects the lives of ordinary people at a time when science is producing convulsive changes and dangerous stresses in our civilization, is merited by many. Scientists, however, are not the only ones who can be indicted as illiterate, inarticulate and irresponsible; very similar charges could be brought against journalists, for example, and so talented an expositor as Mr. Calder was obviously overstating his case when he argued that mass appeal and the box office returns should be the sole and final arbiter in the presentation of science.

To accept that view is to accept defeat. The terms of public exposition may well be set, as Mr. Ritchie Calder argued, by the nature of the mass mind or popular understanding. Neither the mass mind, nor popular understanding, is to be accepted as unchangeable, nor have they been accepted as such by the British Broadcasting Corporation, for example. The real task undoubtedly lies in the teaching of science in the schools, and from this point of view, as well as from that of the supply of scientists themselves, the shortage of science teachers is a problem to be tackled with the utmost energy and dispatch.

If, however, the presentation of science through the press, radio, television and the cinema is to be governed by quite low standards, as Mr. Calder suggested, even the best science teaching in the schools will fail to provide us with a public which really understands the possibilities of science, the implications of scientific advances, or, still less, is interested in science for its own sake. The presentation of science must be governed by some ideals and standards above those of financial return.

None the less, Mr. Calder gave another important reason why the scientist must himself take much more seriously the task of public exposition and interpretation. The steadily growing dependence of

research upon public funds means that the public has a right to some clear understanding of what is being done with the large sums of money now voted for such purposes. Unless scientists take some trouble to explain the reason for such research and explain its progress, they are not entitled to complain if funds are withheld or curtailed; and if national interests are thereby injured, perhaps irretrievably, the real responsibility lies on the scientist who has failed to explain the situation clearly and firmly to the nation.

Mr. Calder, like Dr. Swinton, looked to the continuous popular exposition of science. The British Association should not, he thinks, limit its activities to its annual meeting, though he is thinking in terms of the press, radio, television and cinema, rather than the local societies. The Association has obviously been challenged at Liverpool, even more clearly than at Belfast or Edinburgh, to address itself as a whole to the task to which the Division for Social and International Relations of Science was dedicated on its formation in 1938. That the Assembly of Corresponding Societies has a large part to play is clear, though some further inquiry may be required to indicate more specifically the best lines of work either for the Assembly or for its constituent units. Meanwhile, the Sections of the Association are equally called upon to reconsider their functions in the light of the criticisms voiced at Liverpool and since. Nor is it too much to hope that scientific societies generally and professional associations of men of science will be stimulated to consider anew their functions in the world of to-day, not merely in regard to the presentation of science, but also to the advance of science itself, alike through the growth of popular understanding and through more effective co-operation between the professional and those others who pursue or seek to pursue science for its own sake.

ROLE OF PLASMAGENES

Nucleo-cytoplasmic Relations in Micro-organisms

Their Bearing on Cell Heredity and Differentiation. By Prof. Boris Ephrussi. (The William Withering Memorial Lectures delivered at The Birmingham Medical School, 1952.) Pp. viii+127+5 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1953.) 18*s.* net.

PROF. EPHRUSSI'S short book is based on three lectures given in the Birmingham Medical School last year. They contain very useful summaries of some of the recent work on cytoplasmic inheritance in lower organisms, particularly of his own studies on respiratory enzymes in yeast, together with those of Sonneborn, Beale and others on *Paramecium*, and the less well-known investigations of Rizet on the barrage phenomenon in the mould *Podospora*. The experimental evidence and the conclusions to be drawn from it are clearly and succinctly presented and form a valuable introduction to the literature. Unfortunately the diagrams, although at first glance appearing clear-cut and simple, are quite inadequately explained and in some cases I have still failed to understand what they are intended to convey.

Ephrussi discusses at some length the bearing of the facts he describes on the fashionable but somewhat nebulous idea that the discovery of 'plasmagenes' goes far towards revealing the fundamental mechanisms of differentiation in multicellular animals. In recent years this notion has been responsible for much muddled thinking, and at least in the first part of his book Ephrussi is not immune from this, although towards the end of it he does something to straighten matters out again. He starts, for example, by quoting a sentence from Darwin: "Inheritance must be looked at as merely a form of growth". But he promptly proceeds to reverse this, erecting a concept of "cell heredity" in which the more general phenomenon of growth, which usually leads to the subdivision of the growing mass by cell division, is considered as secondary to the more specialized phenomenon of heredity. This concept, which several authors have used, almost inevitably leads to attempts to draw parallels between two quite different processes; on one hand, the passing on of cytoplasmic constituents (plasmagenes), which are distributed from a cell to its daughters merely because the original cell is cut in half, and on the other the transmission of nuclear genes through the elaborate mechanism of gamete formation and fertilization. A property of genetic continuity is attributed to both nuclear genes and plasmagenes, but the evidence for it is of quite different, in fact almost opposite, nature in the two cases. Nuclear genes are considered to exhibit genetic continuity because they continue in existence throughout lengthy series of crosses, etc., whereas the evidence for the continuity of plasmagenes is the fact that if they are got rid of they cannot be regenerated.

Attempts to bring plasmagenes into play to explain differentiation also lead to confusions. The phenomenon to be explained is the arising of new and diverse types of tissue. If the immediate cause of the appearance of a tissue is the occurrence of the appropriate plasmagene, we have two possibilities. Either the plasmagenes arise *de novo* during development, in which case they are doing exactly that thing the impossibility of which is used as a means of detecting them; or they are all present, possibly in an inactive form, in the unfertilized egg, in which case they are nothing but our old and discredited friends the 'organ-forming substances' appearing under a new name and with their hair curled in the latest fashion.

The true importance of the plasmagene work for the study of development would seem to be that it has brought home to geneticists a fact long realized by embryologists and cell physiologists, namely, that the cytoplasm is not a mere sackful of small-molecular products thrown out by the genes, but contains particles of at least the same order of size and complexity as the genes themselves, though it seems that only very rarely in higher animals can these particles take the lead in cell functioning.

Ephrussi seems to be gradually approaching some such position as this. True, he starts off on the wrong foot, arguing rightly enough (on p. 4) that development involves a "differential [which] must have its seat in the cytoplasm", but drawing the complete *non sequitur* that "if the cytoplasm causes differentiation it must be endowed with the power of perpetuation of cell-type". But by pp. 105–6 he has come to the more convincing opinion that "the cell is an integrated unit which can be broken down only for purposes of analysis" and "we may therefore

speak of autoreproduction of the integrated unit which is the cell, but it would be more correct not to speak of autoreproducing particles". The journey from the earlier view to the later not only exhibits a fascinating panorama of facts, but also is of the greatest intellectual interest and stimulus. Ephrussi's book should certainly be read and deeply pondered by all who are interested in the fundamental questions of biology.

C. H. WADDINGTON

EXPERIMENTAL DESIGN IN BIOLOGY

The Design and Analysis of Experiment

By M. H. Quenouille. Pp. xiii+356. (London: Charles Griffin and Co., Ltd., 1953.) 36*s*. net.

THIS book, according to the author's preface, "is aimed at those wishing to acquire a working knowledge of experimental design and an understanding of the principles governing it". The subject is approached from the point of view of biological experimentation, and all the examples are drawn from this field. The book is designed for readers with a comparatively slight mathematical background, and the results are for the most part presented without proof. It is divided into four sections: elementary principles and designs; incomplete block designs; long-term policy; and experimental complications.

The reader is assumed to possess some knowledge of statistical method up to analysis of variance and regression, and also of the basic principles of experimentation; these topics are summed up in a somewhat indigestible first chapter. The remainder of the first two sections is devoted to the more familiar experimental designs, the account of the construction and analysis of each type of design being generally followed by a clearly worked example. These examples are drawn from a wide range of biological experiments—they are discussed in some detail and are well chosen to illustrate the suitability of the particular designs used.

In the third section, the planning and analysis of groups of experiments are discussed. In particular, detailed consideration is given to methods of design and analysis for estimating residual effects of treatments, and to the combination of results from experiments with differing precision. The topics of this section have been comparatively neglected, and many of the methods described should prove useful both to statisticians concerned with planning groups of experiments, and to the experimenters themselves, although the treatment requires more familiarity with statistical techniques than most experimenters may possess. This is perhaps also true of the fourth section, in which, among other things, are discussed a number of special designs which may be required in peculiar circumstances (for example, $p \times p$ factorial designs with missing diagonals), and the transformation of experimental observations. These sections are useful in collecting together the results of researches which have been carried out in various fields in recent years. There is an extensive and useful bibliography with many references to both theoretical and practical sources.

The author has, perhaps, tried to include too many topics in one volume. This results in the first half containing insufficient detail for those entirely new to experimental design, while in the latter half are included some sections (such as that on sequential analysis) in which the treatment is too brief to be of much value. It is difficult to recommend this book whole-heartedly to experimenters or to statisticians; however, it contains material which should be interesting and useful to both groups.

INTERPRETATION OF NUCLEAR DATA

Theoretical Nuclear Physics

By Prof. John M. Blatt and Prof. Victor F. Weisskopf. Pp. xiv+864. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1952.) 100*s*. net.

PROFS. BLATT AND WEISSKOPF have written an excellent account of the present interpretation of nuclear data, and their book will doubtless become a standard work. Nevertheless, it does not pretend to contain a complete nuclear theory: in addition to the inevitable complexity of the many-body problem we still do not know the elementary law of force between nuclear particles or how the forces between individual particles add up, and some physicists doubt whether the concept of a potential energy between nucleons is valid. In this situation it is a merit of the book that much of the discussion is in terms of general concepts rather than of special models. For example, in the two-body problem considerable use is made of the theory of 'effective range' which does not need to assume any specific shape for the potential between nucleons.

Three chapters, totalling about 250 pages, are devoted to nuclear reactions, mainly to the discussion of the dispersion formula. Some powerful theorems on angular distributions and correlations are included. Chapter 10, on the formal theory of nuclear reactions, also contains a clear account of the relationship between the principles of reciprocity and detailed balance for the transitions of a quantum mechanical system; a matter which has often been confused in the literature through undue reliance on simple perturbation theory. These chapters will be very useful to the experimental worker, though Chapter 8 makes heavy reading. Together with so much general theory it would have been helpful to include a simple explicit example of how analysis of angular distributions can lead to assignment of spins and parities.

An indication of the experimental progress of recent years is that Profs. Blatt and Weisskopf, unlike most previous authors, make no attempt to include a table of nuclear species and their elementary properties; this task now occupies a special publication of telephone directory dimensions. The shell model of low-lying nuclear states, which represents the consequent theoretical progress, is treated in the last chapter of the book. It is a pity that this model was not available to the authors when the earlier chapters on nuclear spectroscopy were written, as a few apparent inconsistencies with the last chapter might have been avoided.

The authors wisely avoid meson theory, so the text can be read by anyone who understands simple quantum mechanics; even the relativistic Dirac equation appears only in connexion with the theory of β-decay.

K. J. LE COUTEUR

MAGNETIC PROPERTIES OF THE EARTH'S INTERIOR

THE renewed interest in attempts to explain just why the earth has a magnetic field, and the feeling of optimism that at last this long-standing riddle of geophysics may soon be solved, were reflected in the contributions to the discussion on the magnetic properties of the earth's interior held on September 4 by Section A (Mathematics and Physics) of the British Association at its Liverpool meeting.

The discussion was opened by Sir Edward Bullard (National Physical Laboratory, Teddington), whose recent contributions to the dynamo theories of the main field and of its secular variation have been mainly responsible for the great revival of interest in this problem. In a most illuminating and entertaining introduction, Sir Edward reminded his audience of some of the important features of the field that call for explanation. The fact that the field resembles that of a uniformly magnetized sphere —that is, a dipole field—was established as early as 1600 by William Gilbert. During the past hundred and twenty years, however, the magnetic moment of this dipole field has decreased by as much as 4·5 per cent, a very remarkable rate of change for any planetary phenomenon. If this were to continue, there would soon be no field left to investigate! "However, I am happy to announce," continued Sir Edward, "that this contingency will probably be avoided, since there is now evidence that the moment reached a minimum about 1935, and appears now to be increasing again."

When the main dipole field is removed, the residual field is one of considerable complexity. A chart of this field is not unlike a meteorological chart in appearance. The resemblance is even closer when one remembers that both charts will change with time, the secular changes in the geomagnetic field during, say, a century being of the same order as those occurring on a weather map during a week. The comparison is perhaps not entirely fanciful and tends to suggest that the geomagnetic phenomena may originate, like the weather changes, from causes associated with fluid motions. Another specially significant feature of the geomagnetic field is the observed westward drift by about 0·2° longitude a year of the general pattern of the secular variation field, this drift being superposed on the general waxing and waning of the individual foci of change.

Sir Edward then reviewed the many and varied explanations, including some that he frankly labelled "magic", which have been put forward to account for the existence of the magnetic field. In view, however, of the features already mentioned and having regard to the reasonable assumptions we can make about the properties of the earth's interior, the only kind of explanation likely to be satisfactory is one which involves the production and maintenance of electric currents flowing mainly in the liquid core. The radius of this core is known with considerable exactness from seismological studies, and there are good reasons for believing that it has a metallic conductivity. The electric currents might be produced by chemical action, or by thermoelectric or dynamo effects. No precise mechanism involving chemical effects appears to have been considered, but mechanisms involving thermoelectric and dynamo effects have both been discussed in some detail.

The possible existence and effectiveness of thermoelectric couples at the interface between the metallic core and the silicate mantle have been considered by Dr. S. K. Runcorn at Cambridge, who has suggested that, if temperature differences caused by heat convection exist on the surface of the core, electric currents will be set up flowing partly in the core and partly in the mantle. Since the thermoelectric e.m.f.'s are radial, the resulting magnetic field would not be the dipole field actually observed, but further interactions with fluid motions in the conducting core could lead to this field. Sir Edward considered, however, that the temperature differences on the surface of the core which are required in this theory are so great that they would imply an unlikely large heat convection within the core.

In the dynamo theory, as developed mainly by Prof. W. M. Elsasser in the United States and by Sir Edward in Great Britain, the electric currents are generated through electromagnetic induction by the interaction of fluid motions in the core with the internal magnetic field of the currents themselves, the whole system forming a self-exciting dynamo which obtains its energy from the heat generated by radioactive material in the core. A heat generation of a few per cent of that occurring in surface rocks would suffice to maintain a convective motion with material rising at some places and sinking at others. The radial component of this convective motion will be affected by the earth's rotation and will lead to a radial gradient of angular velocity of the fluid, the outer part of the core rotating more slowly than the inner part. Since a highly conducting fluid will tend to carry any magnetic field along with it, this retardation of the outer part of the core may be the cause of the westerly drift of the secular variation field. The convective streaming in the fluid core together with the differential rotation might, in the presence of some small initial magnetic field, build up and maintain the field at some definite level; in other words, the core would behave as a self-exciting dynamo. To prove rigorously that this is possible, it is necessary to show that Maxwell's equations for a moving fluid possess solutions of the necessary type. This analytical problem has been studied by Sir Edward, and he believes that it will be feasible to establish the possible existence of such a dynamo. The analysis is, however, extremely complex, as the large gathering fully appreciated when some of the equations involved were shown on the screen.

Prof. A. T. Price (University College, Exeter) then described how the study of short-period fluctuations of the geomagnetic field can yield information about the distribution of electrical conductivity within the earth. Though this information is rather limited, due account must be taken of it when seeking to explain some of the features of the geomagnetic field, especially the secular variation. Several types of fluctuation have been studied; but most work has been done on the daily variations and the storm-time variations. Both these are primarily of external origin, being due to varying electric currents in the ionosphere; but these ionospheric currents induce other currents within the earth, and a comparison of the magnetic fields of the inducing and induced

currents can tell us something about the electrical conductivity of the region where the induced currents flow.

The calculations which have so far been made indicate a considerable rise of conductivity with increasing depth within the earth, from about 10^{-16} e.m.u. or less for dry surface rocks to a value of at least 10^{-11} e.m.u. at about 900 km. depth. No direct information about greater depths can be obtained from the magnetic variations, because the corresponding induced currents do not penetrate appreciably farther than this. If, however, the observed rise of conductivity can be accounted for on some reasonable hypothesis based on known physical laws, it may be possible to extrapolate the results to greater depths with some degree of confidence, and this has in fact been done. A very reasonable supposition is that the increase of conductivity is associated with the increase of temperature as one goes downwards in the earth. The material of the earth's mantle is probably some form of olivine, and is in any event almost certainly a semi-conductor, in which the conductivity σ at high temperatures will be a function of the temperature T of the form $\sigma=\sigma_0 \exp(-A/kT)$. The coefficients σ_0 and A may depend somewhat on pressure and temperature; but the important changes in σ will be due to the exponential factor.

Laboratory measurements of the conductivity of various olivines at temperatures up to 1,500° C. have recently been made by H. Hughes at Cambridge, following some earlier work done there by H. P. Coster. These experiments reveal a very great increase of σ with temperature, and it appears that most of the materials examined behave like ionic semi-conductors at sufficiently high temperatures. From his results Hughes has determined the relevant values of σ_0 and A. He has also obtained corresponding values of these coefficients for the earth's mantle by comparing the distribution of conductivity, as derived from the geomagnetic data, with recent estimates of the distribution of temperature within the earth. The values he obtains, $\sigma_0=2\times10^{-3}$ e.m.u. and $A=3{\cdot}5$ eV., are of the same orders of magnitude as those derived from his laboratory studies. He has therefore used the above formula to extrapolate for σ throughout the mantle, and thus obtains an estimated value of about 3×10^{-8} e.m.u. near the base where it meets the liquid core. This is somewhat higher than earlier estimates. One consequence of a higher conductivity of the mantle would be a tighter electromagnetic coupling between the mantle and the core, and this seems likely to remove one of the difficulties which appeared hitherto in the explanation put forward by Vestine, and by Munk and Revelle, to account for certain sporadic variations in the length of the day, which appear to be associated with variations in the rate of westward drift of the secular variation field.

Another important aspect of the geomagnetic field was discussed by Mr. J. Hospers (University of Cambridge), who described geological evidence which indicates the occurrence of repeated reversals of the main field. He gave an account of work recently done on the natural permanent magnetization of lava flows and sediments found in Iceland. The historic flows of Mt. Hekla, 1766–1948, are magnetized approximately in the direction of the present local geomagnetic field, and their magnetism has undoubtedly been acquired through cooling in the existing field. For the post-glacial lava flows, about 2,000–6,000 years old, the angle of mean direction of magnetism with that of the present field is 7·5°, and with that of the dipole field is 2·5°. This suggests that over a period of some thousands of years the magnetic pole has been centred on the geographic pole. Early Quaternary flows show, however, a reverse magnetization, and Tertiary flows show alternating series of normal and reverse magnetizations. T. Nagata, in Japan, has shown that certain specimens of pumice from Mt. Haruna can acquire a reverse magnetization on cooling in a magnetic field; but no similar effects have been found for any of the Icelandic lavas. The observations, therefore, indicate that repeated reversals of the local magnetic field have taken place; moreover, since the changes have all corresponded to the field swinging right through 180° without intermediate directions being in evidence, it seems probable that the reversals of the field are in fact world-wide. This implies that the main geomagnetic field can reverse its direction every 2×10^5–5×10^5 years, and that this has been happening at least since Miocene times—that is, for the past 20×10^6 years.

The mean direction of magnetization of the Tertiary flows is very close to the direction of the present dipole field. This suggests that, unless the magnetic axis has departed appreciably from the rotation axis, which seems unlikely from the foregoing evidence, there have been no appreciable changes in latitude or orientation of Iceland during the past 20×10^6 years. Some further work on Eocene flows in Northern Ireland, which are about 50×10^6 years old, indicate that, if any polar wandering occurred during Tertiary times, it was much less than has sometimes been supposed.

In the final paper to the symposium, Dr. F. J. Lowes (University of Liverpool) discussed the possibility of attributing the earth's magnetic field to currents produced by thermoelectric effects at the interface between the core and mantle, and examined the implications of this hypothesis. The existence of a considerable voltage distribution is required on the surface of the core, and this in turn requires considerable temperature differences, which are assumed to be produced by the convective motions within the core. The resulting currents would, however, flow in the mantle as well as in the core, in contrast with the situation in the dynamo theory, where the most intense currents flow well within the core. There is, moreover, a difficulty in the dynamo theory in that the changing currents which give rise to the secular variation must flow, owing to the skin effect, within 10–100 km. of the surface of the core, whereas the liquid eddies required to produce these currents would have radii of about 500 km. In the thermoelectric theory this difficulty is avoided because changes in the voltage distribution would directly affect the currents flowing in the mantle, and lead to the observed changes in the magnetic field. The thermo-electric theory also seems to fit in better with recent explanations given for sporadic changes in the length of the day. These are thought to be due to transfers of momentum between mantle and core, the necessary torques being of electromagnetic origin. This requires magnetic fields of order 10–100 gauss in the lower part of the mantle, a condition which is probably more easily met in the thermoelectric than in the dynamo theory. It must, however, be admitted that the difficulty of providing sufficiently effective thermoelectric forces at the core–mantle boundary still remains.

A. T. PRICE

PROGRESS OF CANCER RESEARCH

THE thirtieth annual report of the British Empire Cancer Campaign for 1952 is a formidable volume of 400 pages (from the Campaign, 11 Grosvenor Crescent, London, W.1). Only a few of the many lines of investigation described in the report can be discussed in this review.

The part played by smoking in the causation of lung cancer is probably the outstanding question of popular interest in cancer research to-day. Lung cancer has increased ten times (some authorities say eighteen times) in less than thirty years, and is well on the way to becoming the most common form of neoplasia in the male. The difference in sex incidence of the disease, the spraying of tobacco crops with insecticide containing arsenic, and the immense number of cigarettes consumed nowadays have all suggested that cigarette smoking might be a factor in lung cancer. Statistical analysis has, in fact, shown this to be the case (Table 1[1]).

Table 1. Cigarette Smoking and Lung Cancer
Of 1,000 men aged twenty-five, the following numbers can be expected to die before the stated age

Age (years)	Non-smokers			Smoking 15–25 cigarettes per day			Smoking 25–50 cigarettes per day		
	From cancer of lung	From other causes	From all causes	From cancer of lung	From other causes	From all causes	From cancer of lung	From other causes	From all causes
55	1	130	131	15	128	143	22	127	149
65	2	298	300	32	292	324	54	288	342
75	3	577	580	52	557	609	90	541	631

The opponents of the 'cigarette theory' could point out that while the consumption of tobacco per head has only increased from 9·1 lb. per annum in 1921 to 9·6 lb. in 1951, the incidence of lung cancer has multiplied ten times in that period; that in Turkey, where the tobacco contains vanishingly small amounts of arsenic, lung cancer is almost as frequent as it is in Britain; that the great increase of the disease might be attributed to mounting atmospheric pollution due to the enormous rise in the use of the internal combustion engine (petrol and diesel); that in Iceland, where industrialization has scarcely begun, lung cancer is uncommon; that Stocks's important work has proved that the incidence of lung cancer in urban districts is roughly proportional to the density of the population.

To all of this the answers would be: see Table 1; that cigarette smoking as against pipe smoking is a comparatively recent custom; that no one would attribute lung cancer solely to cigarette smoking, which can be regarded as a synergistic factor to atmospheric pollution just as sunlight and genetic factors are synergistic for cancer of the human epidermis (xeroderma pigmentosum), chemical carcinogens and genetic factors are synergistic for lung and liver cancer in the mouse, carcinogens and the Shope virus for skin cancer in the rabbit, and carcinogens and Bittner virus for mammary cancer in the mouse[2].

The report gives an account of investigations on the effect of cross-breeding on tumour induction which are of extraordinary interest. Pybus and Miller have been working on lines similar to those of Strong in the United States, who injected mice with a single dose of carcinogen (methylcholanthrene), and had found that the untreated descendants of these mice were particularly liable to stomach tumours without the necessity for any further injection with carcinogen.

The effect of crossing two inbred lines of mice (female lung cancer-rates 7·5 and 1·6 per cent) was to increase the lung adenoma rate in the hybrids; but reciprocal crossing had the strange effect of almost doubling the lung tumour-rate: 20 per cent of the females developed lung tumours as compared with 9 per cent in the reciprocal cross. Methylcholanthrene increased the incidence still further to 31 per cent. "In the uninjected descendants of injected mice the lung tumour incidence was less than in the control hybrids; this suggests that the methylcholanthrene acted directly on the lung tissues and that there was no genetical effect." The mice were injected once only at 60 days of age; the lung tumours appeared in 9·8–22·4 months in males and between 14·4 and 27·9 months in females.

The incidence of mammary carcinoma presents some puzzling features. Neither the inbred strains *NBT*, nor *CBA*, nor their descendants developed mammary cancer, but the crosses did; *NBT*/*CBA* hybrids (the maternal strain is given first) showed 3·8 per cent tumour bearers, the reciprocal cross (*CBA*/*NBT*) gave 1·6 per cent. These figures represent the average for twelve consecutive generations, for most of the mammary tumours appeared in the first two generations of hybrids where the incidences were 10·3 and 5·5 per cent in *NBT*/*CBA* hybrids and 5·2 and 4·1 per cent in *CBA*/*NBT* hybrids. "These figures suggest the presence of a weak maternal influence in the *NBT* mice but more than twice as potent as any corresponding influence in the *CBA*. The incidence dropped markedly in later generations, where only an occasional case occurred."

Dmochowski, in experiments on mouse mammary cancer induced by the milk factor, has found that, after strains of mice which are very seldom liable to this tumour have been inbred a number of times, a generation can appear which develops the disease and carries the transmissible milk factor; sometimes seven or even ten generations may have remained free from tumours and milk factor. Infection is not thought to be the responsible mechanism (as tests on close bodily contact between a milk-factor carrier and a factor-free mouse have demonstrated in experiments by Andervont *et al.*).

Does the virus-like milk factor arise *de novo*? The investigators engaged in this work show something like panic at the thought of such heresy. They say: "Without experimental facts it would be sheer speculation to suggest how it comes about that the milk factor is now detectable in this sub line". (However, one plant-virus authority believes that there exists some evidence of *de novo* appearance of virus in the potato[3].)

At Leeds, Bonser and colleagues have obtained some evidence in favour of the metabolite theory, which postulates that a carcinogen has first to be converted to its hydroxy derivative before carcinogenesis can proceed. β-Naphthylamine, while a potent carcinogen for human bladder epithelium (dye-workers' cancer), has been found to act exclusively in the dog and not in other experimental animals when it is administered by conventional methods such as in the diet. Bonser's technique consists in

inserting wax pellets containing carcinogens surgically directly into the bladders of mice; it was found that 1 hydroxy-2-amino naphthol was carcinogenic, but that the amine itself was not. However, benzcarbazole *per se* was active.

The majority of the reports on strictly morbid anatomy are of the type—case reports, and collections of cases from the files of a department to illustrate some particular point—which constitutes the bread-and-butter of publication of any university pathological department. Save that most of the items deal more or less directly with cancer of some sort, one can find little evidence that the work of the pathologists supported by the Campaign differs in any way from that of their colleagues in general.

There would seem to be three types of project in this field in which the support of such a body as the Campaign could be of decisive importance. The first is the massive co-operative effort, typified by Dr. W. L. Harnett's "Survey of Cancer in London" (reviewed in *Nature*, 170, 220; 1952); no scheme of equal scope seems to be under way at the present. The second is the prosecution of research overseas, in areas where pathological facilities are inadequate, into the tumours characteristic of those regions, and the elucidation of which is often of the greatest value for the study of tumours in general. There is no suggestion of such work in the present report. An investigation into the carcinogenicity of *Acacia arabica* by Dr. R. Schoental, derived from observations by Dr. V. R. Khanolkar on the frequency of glottal and tonsillar cancer in Gujrati Indians who use acacia twigs as toothbrushes, and continuation of the same investigator's work on *Senecio* liver tumours, is the only reference to the incidence of cancer in non-white races. The third type of project is the long-term study of a single group of tumours in all possible aspects, at a single institution, by standardized methods, and so far as possible by the same people throughout. Of this type the report mentions one old, honoured and outstandingly successful example, and several hopeful juniors.

The major example referred to is, of course, the investigation at St. Mark's Hospital, under Dr. Cuthbert Dukes, into tumours of the colon and rectum, which must now be approaching the end of its third decade. Dr. Dukes's series of cases of familial intestinal polyposis now includes 41 families, with 753 members, among whom there have been 156 cases of polyposis: much valuable information arises from their study. Studies of the malignant rectal polyp and of the large villous tumour of the rectum are also presented. Individually these appear pedestrian in the extreme; but that is characteristic of this kind of investigation: much of it is what Dr. Dukes himself has described as "the luxury of proving what we already know to be true". But over the years a body of exact and unique information has been built up, more, probably, than is available for any other group of tumours in the body.

It may serve as a useful cross-section of the pathological material contained in this report to give a résumé of work on one single aspect, cancer of the lung. These are all the relevant articles found: (*a*) the joint clinical-therapeutic study shared between the Cancer Hospital and the Brompton Hospital; (*b*) a study of pneumonectomy specimens in progress at the Middlesex Hospital; (*c*) a search for carcinogens in cigarette ends, by chemical means, at the London Hospital; (*d*) investigations by Sir Ernest Kennaway into the carbon content of human lungs, into the incidence in coal miners, and into the curious relationship between the incidence of cancer of the lung and the larynx in various districts of England and Wales; (*e*) experimental studies at Leeds; these last have had as their main result to date the observation that a potent carcinogen absorbed on carbon, inhaled as dust and retained in the lung, will not produce lung tumours in mice; suggesting that direct animal experiment will not give a simple answer to any problems connected with the carcinogenicity of, for example, cigarette smoke. The difficulty here is very similar to that emphasized by work on carcinoma of the stomach at Leeds, also described in the report, where again known carcinogens have failed to produce tumours in what appeared to be the most favourable possible circumstances. Whether the answer is one of species difference, of the activity of a carcinogen not recognizable as such in standard animal experiments, or of the absence of any external carcinogen, the fact remains that the experimental study of these two tumours, so common and important in man, has not yet borne any fruit at all, and that the study of human material remains for the present the only profitable line of attack.

In the field of physics this report shows that work continues to cover an ever-widening field, and that the problems studied have a very wide variety of starting points, ranging from the investigation of the structure of proteins to measurements on a 1,000-C. cobalt-60 source. The problems connected with the production and measurement of megavoltage radiation are being studied at a number of centres. Various methods of production of such radiations are now in routine use and a wide variety of protection problems arise as a result. The contamination due to radioactive dust arising from the use of cobalt-60 sources has been reported and various methods suggested for overcoming this complication. The absorption of high-energy radiation in a selection of high-density liquids has been studied with the aim of designing a transparent window through which patients can be observed while undergoing treatment; solutions of lead perchlorate were found to give encouraging results.

Scintillation counting appears to be receiving widespread notice and its applications are becoming increasingly varied. The photomultiplier system used with these counters has now been applied to the measurement of 'chemi-luminescence'—the light emission which may accompany chemical reactions; while scintillation dosimeters of very small dimensions suitable for the measurement of dosage-rates in body cavities or around interstitial implants are also reported.

The main advances in the use of radioactive isotopes seem to be in the investigational and diagnostic field rather than in therapy, though improvements in existing therapeutic techniques have been achieved. Side by side with these technical advances, work continues upon the development of reliable methods for the standardization of measurements of the radiations emitted from the many different isotopes used in the medical field. The use of iron-59 for the study of blood conditions in malignant disease and as an indication of the total whole-body irradiation received during treatment with ionizing radiations is being given careful attention. The uptake of sulphur-35 in bone marrow and the localization of phosphorus-32 within the cell are being studied with improved techniques of autoradiography.

The study of protective agents during irradiation is widespread, and varies from the shielding of certain specific parts of an animal being irradiated and the use of 'sieves' during therapy, to the administration of chemical agents prior to irradiation. The effect in bone due to irradiation by 220-kV. and 2-MeV. beams and also the relative loss of phosphatase in mouse bone after irradiation by beams of energy varying from 100 to 1,000 kV. offer interesting evidence of the biological response to such radiations.

[1] Heady, J. A., and Barley, R. G., *Brit. Med. J.*, I, 1105 (May 16, 1953).
[2] Goulden, F., Kennaway, E. L., and Urquhard, M. E., *Brit. J. Cancer*, **6**, 1 (1952).
[3] *Chem. and Indust.*, p. 820 (August 1, 1953).

NEW FISHERIES LABORATORY, BURNHAM-ON-CROUCH

By Dr. H. A. COLE

A NEW Laboratory for research on inshore and shellfish problems was formally inaugurated at Burnham-on-Crouch, Essex, on September 23 by Mr. G. R. H. Nugent, M.P., joint parliamentary secretary to the Ministry of Agriculture and Fisheries, at a large gathering of representatives of local authorities in Essex, the sea fisheries committees of England and Wales, the shellfish industry and the universities and marine laboratories. Mr. Nugent was introduced by Mr. Michael Graham, director of fisheries investigations; Mr. E. R. Chadwyck-Healey, prime warden of the Fishmongers Company, and Mr. T. Driberg, M.P. for Maldon, also spoke.

The Laboratory is intended to serve as a centre for the wider investigation of inshore and shellfish problems than has hitherto been possible in the somewhat restricted accommodation provided by the Fisheries Experiment Station, Conway. Work will continue at Conway with a reduced staff on certain problems, notably the selective breeding of oysters and the cleansing of shellfish, for which the station is especially equipped.

The staff at Burnham comprises six scientists with technical and clerical assistance. The Laboratory is equipped with two research vessels. The larger, *Wystrys*, a converted oyster smack built at Whitstable nearly thirty years ago, saw war service with the Sunderland pilots. She is 50 ft. overall and is equipped with a specially designed trawling gallows from which two 4 ft. 6 in. dredges can be worked. The smaller vessel, *Jassa*, was recently built at Leigh-on-Sea and, although only 32 ft. in length, also works two large dredges. She has been designed as a general-purpose vessel for shrimp trawling, dredging and general research work.

The Laboratory has also been provided with about a hundred acres of experimental oyster grounds in the Rivers Crouch, Roach and Blackwater, some of which have been purchased while others are leased. Many were derelict when taken over and the principle of the reclamation methods is to introduce mechanized cultivation at stages discovered by biological research to be critical, bearing in mind the economic factors. The work is providing new information on the control of pests and on the factors affecting the productivity of oyster grounds.

The Burnham Laboratory has been designed along simple functional lines with a preparation room, six research laboratories, a general laboratory, tank room, library, dark room, workshop, stores and offices, all on one floor, with a central corridor running the full length of the building. The construction is brick on a reinforced concrete secular raft, with a flat roof.

The site is immediately inside the sea-wall at the eastern end of the river front, and the Laboratory faces north-west on to open country. Sea water is delivered by special electrical pumps with hardened rubber casings into two cast-iron storage tanks on the roof of the Laboratory, from which discharge is by gravity to six small concrete tanks and a double row of sinks in the laboratory tank room. The larger piping is in cast-iron with an inert inner coating; the smaller piping is in ebonite. There is no recirculation of water, which is discharged to waste. Pumping arrangements are to a large extent automatic; but special provision has been made for flushing silt from the intake mains, as in the River Crouch the water is often very turbid. Compressed air is provided in all laboratories and in the tank room.

This is the first laboratory specially built for fishery research in the United Kingdom during the seventy or so years since its inception. The Crouch–Roach river system and the Thames area provide facilities for research on many inshore and shellfish problems. In addition to the important oyster fisheries in the Rivers Colne, Blackwater, Crouch and Roach, and at Whitstable, there are large shrimp fisheries based on Leigh-on-Sea, Tollesbury, Harwich and other ports; one of the largest cockle fisheries in Britain is based on Leigh-on-Sea, with many communities of inshore fishermen between Harwich and the North Foreland. The vast shellfish beds in

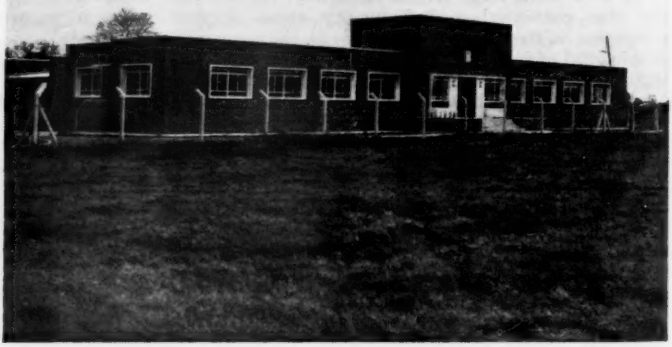


Photo by "Sport and General"

Fig. 1. The new Fisheries Laboratory of the Ministry of Agriculture and Fisheries at Burnham-on-Crouch, Essex

the Wash, the most important in point of yield in England and Wales, are within easy reach. Rail access to London is good, and it is hoped that the presence of a fully equipped marine station in this area will be taken advantage of by members of universities, for whom there is a certain amount of laboratory space.

Work was begun at Burnham-on-Crouch in 1947 in temporary quarters, and attention was concentrated first on the difficulties of the East Coast oyster industry, the productivity of which was at a low ebb, following the effects of the War and the exceptionally severe winters of 1940 and 1947, which aggravated a situation already difficult following the spread and multiplication of two imported oyster pests, the American slipper limpet, *Crepidula fornicata*, and the American whelk tingle, *Urosalpinx cinerea*. The research programme will gradually be expanded to include the study from the fishery aspect of all species of molluscs and crustacea of commercial importance; the economics of the inshore fishing industry will require examination at the same time. Current research work at the new Laboratory includes an investigation of the causes of fluctuations in the annual production of seed oysters in Essex; the control of oyster pests; an examination of the losses resulting from the relaying of oysters; the causes of the fluctuations in the pink shrimp fishery of the Thames area; the biology and control of the mussel parasite, *Mytilicola intestinalis*; the overfishing of cockle beds in South Wales; an examination of the fishery aspects of the 'white weed' industry (*Sertularia cupressina*); and a detailed study of the taxonomy and ecology of the small marine algæ which are of such importance as food for marine larvæ.

The inshore fauna of the rivers and creeks of the Essex coast has been little studied and has proved to be of great interest. In shallow water the benthic community is dominated by *Crepidula*, with, in some areas, vast quantities of ascidians, principally *Ascidiella aspersa* and *Ciona intestinalis*. Silt in suspension greatly affects the composition and distribution of the fauna, which is highly specialized, with close resemblances to the communities found in the Oosterschelde and the Wattenmeer, across the North Sea. Peculiar salinity conditions are also to be found in the rivers and creeks, which are in reality embanked inlets in the marshes. In the upper reaches in summer, salinity often exceeds 35 ‰, and temperatures of more than 20° C. may occur for several weeks at a time. Interchange and mixing with the North Sea is very slight in summer as the rainfall is low. As a result of these peculiar hydrological conditions there exists in the creeks a strongly marked community of animals which differs markedly from that found on more open coasts north and south of the Thames Estuary.

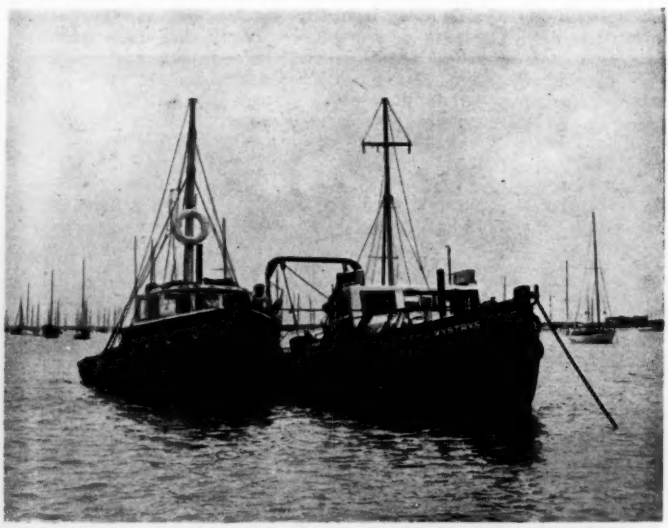


Photo by "Sport and General"

Fig. 2. The research vessels *Jassa* and *Wystrya*

THE SALDANHA SKULL AND ITS ASSOCIATIONS

By Prof. M. R. DRENNAN
University of Cape Town

THE expanding story of early man is a composite one, depending for its growth and documentation on the evidence from fossil remains and stone implements. It is in the nature of things that his stone implements should have survived the passage of time to a far greater extent than his bony remains. Only rarely, and often in unexpected places, do we get those fortuitous circumstances that lead to fossilization.

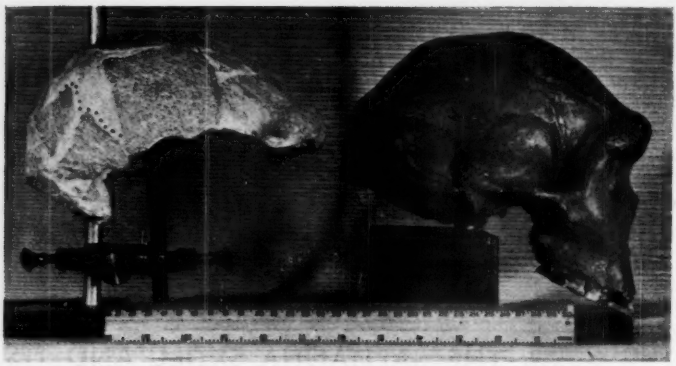
This is particularly true of that early stone-knapper, whom we call 'hand-axe man', because we know very little about him beyond the fact that he continued to make this implement to a more or less standardized pattern during the longest of human cultural spans, namely, the lower palæolithic.

In Europe the faunal remains of this period have survived to a considerable extent, and they reflect the cold and warm alternations of the Ice Ages. Human remains, however, are still very scarce, and at the moment are limited to two incomplete and apparently sapient human skulls, one from a Thames' terrace at Swanscombe, and the other from the Fontéchevade cave in France.

In South Africa, the hand-axe culture abounds in all the old river terraces; but for the most part the implements of this period are unaccompanied by bone. The one exception, so far, is the Vaal River, where the intensive search for diamonds has led to the discovery of valuable fossil remains.

The Site and Associated Fossils

In the Cape of Good Hope region, however, it is only within the past two years that the disparity between stone implements and fossils has begun to be redressed. This has been done by a group of scientific workers from the University of Cape Town, who have been studying a rich exposure of stone implements and fossils on a farm called 'Elandsfontein', owned by Mr. S. P. Lategan, and situated eighty miles



Side view of the Saldanha skull-cap and of a cast of the Rhodesian skull

due north of Cape Town. The fossiliferous area lies in the centre of a somewhat barren twenty-mile wide strip of sandy bush veld, bordering on the almost landlocked Saldanha Bay and Lagoon.

The exposures, which have been shown from a recent survey to extend over an area of several thousand acres, are the result of wind erosion, the south-east wind having scoured out troughs and valleys, winnowing out the fossils and stone implements, and driving the sand northwards in vast moving sand dunes.

The University committee responsible for the investigation of the site has been fortunate in having the services of Mr. J. A. Mabbutt, lecturer in geography, who was already studying the physical geography of the adjoining Berg River. His findings may be summarized as follows. The fossiliferous area is situated on a low sandy plateau, 300 ft. above sea-level, and the fossils and implements have obviously been derived from the erosion of old pan floor deposits and their flanking dunes. It would appear from a study of the sand that the fossils lie in a zone of contact between old coastal shelly sands stretching west to the Atlantic, and brown inland sand on the eastern, landward, side. Curious ridges of ferruginous sandstone (ferricrete) which abut on the limestone (calcrete) suggest an earlier higher water-table, possibly even a wetter period, with dammed-up vleis or ponds providing an attraction for the game and also for the hunters.

On a recent visit Mr. Mabbutt dug a trial pit on the main site, and he was successful in locating the original bedding layer of the fossils.

Mr. Keith Jolly, field officer for the work, has made an extensive collection of the stone implements and fossils. The former comprise a technological sequence of late Stellenbosch (Chelles-Acheul) hand-axes and a rich assemblage of pigmy hand-axes and cleavers suggesting the presence on the site of exponents of the Fauresmith (proto-Mousterian) industry of the northern provinces of South Africa. In addition, there are good examples of the bifaced points of the Still Bay industry of the later South African Middle Stone Age.

My two senior assistants, Dr. E. N. Keen and Dr. R. Singer, have studied the mammalian fossils which have so far been collected, and they have established the fact that a considerable proportion of the bones and teeth represent extinct types of African mammals. One of the most striking of these is the giant-horned buffalo, labelled tentatively *Homoiocerus bainii*. Another giant form that occurs is the warthog (*Mesochoerus*), which has teeth greatly exceeding in size those of any of the living forms of this animal. An archaic form which is well represented is the African mammoth (*Palaeoloxodon*), and there is one set of teeth of the rare primitive giraffe (*Griquatherium*).

The Equidæ are very numerous and in this respect the site seems almost to rival Solutré. In addition, there are many examples of the teeth and jawbones of existing rhinoceros, hippopotamus, and antelopes; indeed, the site is littered with the horn-cores of the last.

Early this year, Dr. H. B. S. Cooke was invited by the University of Cape Town to give a general report on the site, and with regard to its fossil content his evaluation was as follows: "The fossil material collected is better preserved and more complete than at any other Stone Age site in South Africa. The only comparable deposits elsewhere in Africa are at Olduvai in Tanganyika and at Omo in Abyssinia".

The Skull

In January of this year, Mr. Keith Jolly collected a number of pieces of human cranial bones, which were found lying contiguously on the sandy surface. On a subsequent visit, the sandy area where the skull was found was systematically sifted, but nothing was found. Later expeditions, however, made valuable additions to the original material, the wind having in the interval exposed these fragments lying some yards away from the original find.

Vertical aspect of the Saldanha skull and of a cast of the Rhodesian skul

The skull, as it now stands, has been built up from twenty-five fragments of its frontal, parietal and occipital bones, and its original owner has been given the local name of 'Saldanha man'. The most striking feature of this skull is its massive brow-ridges and sloping forehead, which compel one at once to institute a comparison with Rhodesian man. In these respects and in the relative lowness of his cranial vault, there is no doubt that there are close affinities between the Saldanha and Rhodesian skulls. There are, however, significant differences, in that the Saldanha skull lacks the post-parietal depression or dent which the Rhodesian shares with the true Neanderthal skulls. In this respect the Saldanha skull resembles Solo man from Java, the recognized Neanderthaloid successor of *Pithecanthropus* (the ape-man of Java). Indications from the attachments of the muscles of the nape of Saldanha man's neck point to his having had the crouching posture of Neanderthal man, whereas the Rhodesian skull shows that he held his head erect like sapient man.

The walls of the Saldanha skull are extremely thick, and I estimate its capacity as in the region of 1,200–1,250 c.c.; that is to say, he had less brain matter than either the Rhodesian or the general run of Neanderthal skulls. Much more significant, however, in my opinion, is the sub-Neanderthal and most definitely sub-Rhodesian disposition of the Saldanha cerebellum in relationship to the occipital lobes of his cerebrum. On the evidence available I have come to the conclusion, therefore, that Saldanha man is anatomically a more primitive variety of the Rhodesian race.

With regard to age, I think I am justified in excluding the Still Bay implements (Middle Stone Age) from being regarded as more than a criterion of terminal dating value. This industry is found in many of the caves in South Africa, and, so far, there has been no suggestion of anything but a sapient type of man as its exponent.

The remaining possible association is with the late Stellenbosch (Chelles-Acheul) and Fauresmith (proto-Mousterian) facets of our Earlier Stone Age (lower palæolithic). That is to say, it would seem that it was a palæoanthropic type of man, such as the Saldanha skull undoubtedly reveals, who practised the last stages of the hand-axe culture in South Africa. This implies an association of the skull with the oldest of the fossil fauna, a view which is greatly strengthened by its equivalent heavy fluorine content, as shown by tests kindly undertaken for us by Dr. K. P. Oakley, of the British Museum (Natural History).

This article is written on behalf of the Hopefield Committee of the University of Cape Town, and with acknowledgments to those benefactors who made funds available for the investigation of the site.

OBITUARIES

Dr. Edwin P. Hubble

THE death of Dr. E. P. Hubble from a heart attack, on September 28 at the age of sixty-three, has robbed the world of astronomy of its leading authority on nebulæ. Born on November 20, 1889, at Marshfield, Missouri, Hubble graduated at the University of Chicago in 1911 and proceeded to the Queen's College, Oxford, as a Rhodes Scholar. He obtained first-class honours in jurisprudence; but his plan to follow a legal career was abandoned when he received an invitation to carry out research at the Yerkes Observatory. His first published paper was on a variable nebula—now known as Hubble's variable nebula. In the First World War he commanded a battery in the U.S. National Army, but reached France only a month before the end of the war. He then spent the best part of a year in Oxford awaiting transport to the United States and demobilization. In the Second World War he worked in the supersonic wind-tunnel laboratory of the United States.

On his return home in 1919 after the First World War, Hubble was appointed to the staff of the Mount Wilson Observatory. He soon established his position as a leading worker in the field of the nebulæ. He showed that diffuse nebulæ owe their illumination to stimulation by radiation from hot stars. He then turned to the classification of the spiral nebulæ and showed conclusively that they are stellar systems lying outside our galaxy. He established a scale of distances from a study of the brightest stars and Cepheid variables in the nebulæ. Working with Humason and the 100-in. telescope, he established the velocity–distance law from the red shifts of lines in the spectra; this increased the reliable distances to which astronomers could plumb the depths of space up to 250 million light-years. He studied the law of the red shifts in all its bearings, aiming always at cutting down the number of conflicting interpretations, and he kept always an open mind on the kinetic or other explanations of the red shifts.

One of the main items on the programme of the 200-in. telescope on Mount Palomar was to secure evidence from the outermost regions of space—up to 900 million light-years—to determine whether expansion was the right answer to the problem and, if so, to find the exact law governing the expansion. It was tragic that Hubble did not live to see this investigation carried through to the end. His last account of the stage reached up to the present was given in the George Darwin Lecture at the Royal Astronomical Society last May.

Hubble was in great demand as a lecturer. In Great Britain he gave the Halley Lecture at Oxford and a course under the Rhodes Trust which was published as "The Observational Approach to Cosmology". His other well-known book is "The Realm of the Nebulæ". He received many awards and honours from learned societies and academies. In Great Britain he was made an Associate of the Royal Astronomical Society (1928) and Hon. D.Sc., Oxford (1939). He received the Gold Medal of the Royal Astronomical Society (1940) and was elected an Honorary Fellow of the Queen's College, Oxford (1949).

F. J. M. STRATTON

Prof. H. Bompas Smith

HENRY BOMPAS SMITH, professor of education in the University of Manchester from 1912 until he reached the retiring age in 1932, died recently at the age of eighty-six. He was at school at Jena before winning a scholarship at Wadham College, Oxford. After a short time as an assistant master at Shrewsbury School, he was headmaster successively of Queen Mary's School, Walsall, and the newly founded King Edward VII School, Lytham. His work at Lytham made him known at the University of Manchester, and caused the University to offer him

a chair which carried with it the directorship of the University Department of Education. There was already an endowed chair of education at Manchester, the Sarah Fielden professorship, which had been occupied for some ten years by the brilliant but somewhat erratic J. J. Findlay, who was more of an idealist than an administrator. Bompas Smith was brought in and given the headship of the Department, primarily to ensure that the wheels should run smoothly, and that the necessary contacts with schools, local authorities and the Board of Education should be handled by an experienced headmaster. It did not work out quite like this. He used to tell that before he had held his chair for six months, his views were brushed aside at a teachers' conference as those of "a mere theorist"; and in any event, in his later years at Manchester, he was more of a thinker than an organizer, though he was notably successful as chairman of the Northern Universities Joint Matriculation Board.

His main intellectual interest lay in philosophy. His best-known book, under the unrevealing title of "The Nation's Schools", is an interesting, and by no means unsuccessful, attempt to inculcate a somewhat conservative philosophy of education without using technical terms. He kept in touch with current developments in psychology, serving to the end of his life on the advisory board of the *British Journal of Educational Psychology*. But he made no original contributions in this field, and was never disposed to believe that a knowledge of psychological theory or technique could replace common sense as part of a teacher's equipment.

Bompas Smith was a kindly man, and genuinely interested in people, but not very quick in getting to know others or making himself known; and this handicapped his relations with the large annual batch of graduates at Manchester whom he taught for their postgraduate course in education. Most of them did not really get to know him, nor he them. Those few who did, obtained real benefit from his wise and balanced outlook upon life in general and education in particular. He disliked controversy, and the Manchester Senate of those days abounded in doughty controversialists. Perhaps he was too reluctant to speak up for his Department, and perhaps, for this reason, the University tended to under-estimate him. But he secured and retained the loyalty and affection of the staff of his own Department.

James Duff

NEWS and VIEWS

Jenner Medal of the Royal Society of Medicine : Mr. A. T. Glenny, F.R.S.

On October 10 Mr. A. T. Glenny was presented with the Jenner Medal of the Royal Society of Medicine, which is awarded on the recommendation of the Section of Epidemiology, for distinguished work in the field of epidemic diseases. Mr. Glenny began his career in 1900 at the Wellcome Physiological Research Laboratories, became head of the Immunological Department before the First World War and retired under the age limit in 1947. He continued to carry on research at the Laboratories after his retirement and is still active after a period of yet unbroken association with the Laboratories of more than fifty-three years. His major concern has been the study of animal responses to soluble bacterial toxins and toxoids, made largely in the course of the routine production of antitoxin in horses. He developed the Römer guinea-pig skin test into a method of assay for diphtheria antitoxin, which is as accurate as many chemical titrations of simple substances. He has taken advantage of the variation of the response of horses to different toxins, to analyse by antitoxin titrations the great complexity of the antigenic constitution of filtrates of cultures of pathogenic anaerobes. Mr. Glenny's most important work is the study of the two types of response to the injection of antigens, the 'primary' and 'secondary' response, which has been fundamental to the development of methods of large-scale prophylaxis against diphtheria and tetanus. This study led to the development of alum-precipitated toxoid, now the standard prophylactic against diphtheria, which has been used with such dramatic results in the past decade in the control of diphtheria in Great Britain.

The Carnegie United Kingdom Trust : Mr. D. N. Lowe, O.B.E.

Mr. David N. Lowe, who has been secretary of the British Association for the Advancement of Science since 1946, has been appointed secretary of the Carnegie United Kingdom Trust in succession to Mr. J. Wilkie, who is due to retire on March 31, 1954. Mr. Lowe, who was born in 1909, was educated at Arbroath High School and at the University of St. Andrews, which he entered as a Kitchener Scholar. He was awarded a blue for hockey, founded a mountaineering club, and held many student offices, including the presidency of the Union and the Students' Representative Council. He graduated M.A. (English and history) and B.Sc. (with first-class honours in botany). After a short period of research on the marine algæ of the coasts of Fife, he became the assistant secretary of the British Association in 1935. At the outbreak of war he accepted an invitation to enter the Civil Service, where he served in the Cabinet Secretariat as secretary of various ministerial committees concerned with priority and allocation of materials. Shortly before returning to the British Association as secretary he was awarded an O.B.E. in the New Year Honours List of 1946. Mr. Lowe has been prominent in local affairs at Dorking, where he has held office in the Congregational Church, and has participated annually in the Leith Hill Musical Festival. It is as secretary of the British Association that Mr. Lowe has become widely known, however, and his services in the critical post-war period, when the fate of the British Association was in the balance, were invaluable. He has filled his present post with distinction, and the fund of goodwill which has remained after recent meetings has been largely due to his exceptional tact and organizing ability.

William McIlrath Fellowship for Research and Teaching in Animal Husbandry

The Australian Commonwealth Scientific and Industrial Research Organization has decided to apply a gift of £A50,000 from Mr. William McIlrath, owner of the Windsor Hereford Cattle Stud, Delungra, N.S.W., to found the William McIlrath Fellowship

for scientific research and teaching in the broad field of animal husbandry. The first to be appointed to this Fellowship is Dr. M. C. Franklin, principal research officer at the Organization's McMaster Animal Health Laboratory, Sydney, who has been engaged on research on animal husbandry for many years, and whose work on animal nutrition is well known. Dr. Franklin will be concerned mainly with work on beef cattle dietetics, and his research will be undertaken in collaboration with the Faculty of Veterinary Science of the University of Sydney and with the Division of Animal Health and Production of the Commonwealth Scientific and Industrial Research Organization. His work will add to the Organization's increasing programme of research on problems affecting the Australian cattle industry while at the same time strengthening university teaching and research. It is clear that there is a great potential for increased production in Australia through the application of scientific knowledge in feeding, breeding methods and other problems of animal husbandry.

David Livingstone Statue

On October 23, a statue of David Livingstone, missionary and explorer, was unveiled at the House of the Royal Geographical Society by Mr. Oliver Lyttelton, Secretary of State for the Colonies. The bronze statue, which occupies a niche in the north wall overlooking Kensington Gore, is the work of Mr. T. B. Huxley-Jones, of Chelmsford. The cost has been largely met by a generous donation from Lord Catto, and in part from the capital of a fund raised in 1903 to set up and maintain a memorial to Livingstone near Lake Bangweulu, which has now passed into the care of the Northern Rhodesia Commission for the Preservation of Natural and Historical Monuments. At the meeting preceding the unveiling, Mr. J. M. Wordie, president of the Royal Geographical Society, described the support which the Society had given to Livingstone and the warm friendship between the explorer and Sir Roderick Murchison. Mr. Lyttelton spoke of the obligation on those now helping the African people to follow the example of patience, tolerance, humanity and dedication set by David Livingstone. Dr. Hubert Wilson, a grandson, representing the Scottish National Memorial to Livingstone Trust, Blantyre, and the Rev. Maxwell O. Janes, of the London Missionary Society, also spoke. One hundred years ago Livingstone was engaged in the first of the three great journeys on which his fame as an explorer rests. On these journeys he pursued unremittingly the objects of his life's work in Africa—the spreading of the Gospel, the acquisition of knowledge of the interior, the fight against the slave trade, and the improvement of the moral and material conditions of the people—and thus initiated a momentous century in the history of Central Africa.

Education for Management

The rapidly growing interest in education for management in Great Britain is often accompanied by references to the lack of facilities compared with those of the United States. The comparison is often unavailing because precise information about the exact position in Great Britain has not been available. To fill the gap, the British Institute of Management has now produced a survey of administrative studies in Britain. This is in two volumes. The first, which has recently been published, covers subjects in the management field taught at universities and national, technical and commercial colleges of further education, and in the courses organized by professional and educational bodies. The second volume will cover short courses at residential institutions and university extra-mural establishments, and training courses carried out by professional and educational bodies and by trade unions, trade associations and individual firms. The survey lists nearly 220 major educational establishments which are known to teach subjects in the management field, including twenty-six universities and fifteen of the larger technical colleges. These two volumes should provide essential raw material for the evaluation of management courses. They should also serve as invaluable guides to all those concerned with management education and training, to lecturers and heads of departments, to training officers in industry and commerce, and to students of management subjects.

Scientific Translations Center of the Library of the United States Congress

The National Science Foundation, with the partial support of the United States Atomic Energy Commission, has set up an organization in the Science Division of the Library of Congress for holding and photoduplicating foreign scientific translations. This body, which will be known as the Scientific Translations Center, will collect its material from many sources, including government agencies, scientific societies, industrial laboratories and universities. Initially, the major emphasis will be on translations from Russian scientific journals, although it is hoped eventually to add material from other languages. Monthly lists of translations newly received will be issued by the Library of Congress; such lists will include notices of translations that are available by direct purchase from commercial and other translating services, but the Center will not supply photocopies of this material. The price list for copies of translations will be as follows: photostats or enlarged microprints, 1.25 dollars for 1–10 pages and 1.75 dollars for 11–15 pages; microfilms, 1 dollar for 1–50 pages. All inquiries relating to the new service should be addressed to the Scientific Translations Center, Science Division, Library of Congress, Washington 25, D.C.

Infra-red Spectra

The increasing use of infra-red spectra, and the expensive nature of the reproduction of these spectra on an adequate scale in journals publishing original research, has been placing such a burden on certain publishing societies that the Royal Society, the Chemical Society, the Physical Society, the Faraday Society, the Institute of Petroleum, and the Society of Public Analysts and Other Analytical Chemists, as well as other interested bodies, set up a joint committee to investigate the matter. The report of the committee, which has now been accepted by the societies, recommends conditions which should be satisfied before infra-red spectra are reproduced in published papers and lays down the format to which such spectra should conform. The committee is investigating the possibility of setting up some organization which will undertake the publication of infra-red spectra, preferably in collaboration with one or other of the American organizations that exist with the same object. As an interim measure, until a full library scheme is in operation, the Chemical Society accepts for deposit copies of infra-red spectra

referred to or published in new papers in its own journals, and offers its facilities to other societies publishing original research. It should be emphasized that deposition of spectra is voluntary on the part of the author, with the object of the spectra being generally available in a form larger than can be printed; it is not a condition of acceptance of papers for publication. All spectra deposited with the Society must be drawn in indian ink, with all other lettering in pencil, on forms obtainable from the General Secretary, Chemical Society, Burlington House, Piccadilly, London, W.1, price 6*s*. per pad of fifty sheets. Photocopies of spectra thus deposited are made available to the public on request to the general secretary of the Society; applications must quote the C.S. number of the spectra desired and must be accompanied by a remittance of 3*s*. per copy per spectrum (post-paid), special rates being available for a large number ordered at one time. Fifty spectra which are already available will be listed in *Proceedings of the Chemical Society* of December 1953; further lists will be published quarterly in the *Proceedings*, and annual lists will be published in the index volumes of the *Journal of the Chemical Society*.

Rhizomorph Formation in *Armillaria mellea*

The importance of the rhizomorph in the evolution of fungi causing root disease has led to further experimental study of the inception and development of the rhizomorphs of a strain of the honey agaric (*Armellaria mellea*) under controlled cultural conditions (S. D. Garrett, *Ann. Bot.*, N.S., **17**, 65, 62; 1953). When a disk of mycelium taken from the margin of a colony is laid on a fresh agar substrate, mycelial growth begins within twenty-four hours and rhizomorph initials can be seen after seven days. The young rhizomorphs have a maximum growth-rate which is about five times that of the normal hyphæ, the characteristic lobed appearance of colonies being largely due to this fact. An interaction was found between carbohydrate and nitrogen in their effects upon both the initial formation of rhizomorphs and their subsequent growth: as the carbohydrate concentration of the medium was increased, so the optimum concentration of nitrogen for the inception and growth of rhizomorphs increased. On a medium of suitable nutrient composition, no independent rhizomorph initials were observed apart from those originally formed around the inoculum disk. On the basis of experimental evidence it is considered that a certain threshold nutrient status is essential for rhizomorph initiation. Once a rhizomorph has started to grow on an agar plate, the depletion of nutrients in its vicinity prevents the formation of new initials.

Microscopes and Accessory Equipment

The new microscope catalogue of R. and J. Beck, Ltd. (69 Mortimer Street, London, W.1), covers a wide range of microscopes and accessories. It gives details of several new types including the reflecting microscope and the universal microscope, and apparatus is described for vertical phase-contrast illumination and fluorescence microscopy. A welcome addition for many workers will be the 35-mm. photomicrographic camera. A notable feature of the Beck equipment is that it is largely designed as interchangeable units. The catalogue has eighty pages, is pleasantly and clearly produced and should be of interest to all microscopists.

Luminescence: Conference in Cambridge

The Electronics Group of the Institute of Physics is organizing a conference on luminescence, with particular reference to solid inorganic phosphors, which will be held in Cambridge during April 7–10, 1954. The first half-day of the meeting will include a lecture on the present scope of the subject and its developments since the last conference of this kind (Faraday Society, Oxford, 1938). The next day, April 8, will be devoted to papers on phosphor applications and future prospects, especially in the fields of cathode-ray tubes, lighting, electroluminescence and scintillation counting. Papers on the physical chemistry and atomic structure of phosphors, both sulphide and other types, and especially on the nature of the luminescence centre, will be read on April 9. On the last day more theoretical ideas on luminescence will be considered, such as the absorption, emission, transport and storage of energy, and the theory of activator systems. During the conference there will be an evening lecture with demonstrations on unsolved problems in luminescence. Further information can be obtained from Dr. S. T. Henderson, Institute of Physics, 47 Belgrave Square, London, S.W.1.

British Institute of Management

The British Institute of Management has recently issued details of its pioneer executive development programme which provides for a series of four-weekly courses to be held at Management House, Hill Street, London, W.1, at intervals over the coming year. The first course opens on November 1. The programme is specially designed to meet the needs of the established executive in the 30–40 age group whose experience to date has been in a particular specialization. The contents of the courses and methods employed are based on recognition of the fact that successful management depends substantially upon the possession of certain thought habits and attitudes of which analytical ability and a social sense are perhaps the most fundamental. Thus corporate life, syndicate work, exercises and reports, speech-training and committee work are vital ingredients of the programme—no wit less important than the informatory lectures which cover the broad field of management and the best current methods. Of particular interest to those concerned in the running of courses is the modification of the case-study procedure to a form appropriate to the maturity and experience of members of the course. In the American schools of business where the case-study method is a significant feature, the preoccupation is with students with little or no executive experience, and the task is therefore different. This facet of the programme is a recognition of a basic difference between contemporary provision in the American schools of business—such as Harvard—where the majority of students have little or no previous experience, and the situation in Great Britain, where the climate of opinion demands that a man should have experience of industry before he undertakes a course of this kind which is designed to develop his managerial ability.

Another interesting feature is the concept of providing a course to aid the individual and personal development of the student. Thus the entire programme permits only twenty-four students working for the greater part of the time in smaller groups. In fact, the extent of personal development can be in direct proportion to the extent of individual participation. The lecturers and tutors are in the

main drawn from industry and are persons of substantial experience in the field they cover. The Institute emphasizes the pioneer nature of the series and hopes that the results of its experiences will be made available for the development of management training on a much wider scale.

The Night Sky in November

New moon occurs on Nov. 6d. 17h. 58m., U.T., and full moon on Nov. 20d. 23h. 12m. The following conjunctions with the moon take place: Nov. 3d. 09h., Mars 6° N.; Nov. 5d. 03h., Venus 7° N.; Nov. 8d. 01h., Mercury 2° N.; Nov. 22d. 19h., Jupiter 3° S. In addition to these conjunctions with the moon, Venus is in conjunction with Saturn on Nov. 14d. 04h., Venus being 0·9° S., and Mercury is in conjunction with Venus on Nov. 23d. 17h., Mercury being 1·2° N. Mercury is in inferior conjunction on November 14 and is not well placed for observation until about the third week in the month; on November 30 it rises nearly two hours before the sun and can be seen in the eastern sky, but owing to its fairly large southerly declination it will not be far above the horizon about the time of sunrise. Venus, a morning star, rises at 4h. 30m., 5h. 30m. and 6h. 20m. on November 1, 15 and 30, respectively. Its stellar magnitude is − 3·4, and the visible portion of the illuminated disk varies from 0·93 to 0·97. Mars, a morning star, rises at about 3h. during November; in the early part of the month it is nearly midway between ρ and η Virginis, and its easterly movement takes it near θ Virginis towards the end of the month. Its stellar magnitude is about 1·9 during most of November, but towards the end of the month it becomes a little brighter and continues to grow brighter for the remainder of the year. Jupiter rises at 18h. 55m., 17h. 55m. and 16h. 50m. on November 1, 15 and 30, respectively, and is conspicuous during the night (stellar magnitude − 2·5) in the constellation Taurus. Saturn, a morning star, is too close to the sun at the beginning of the month to be seen, but at the middle and end of the month it rises at 5h. 15m. and 4h. 30m., respectively, and can be seen in the constellation Virgo not far from the fourth-magnitude star κ Virginis. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich: Nov. 16d. 17h. 25·3m., λ Psc. (*D*); Nov. 21d. 01h. 12·8m., η Taur. (*D*); Nov. 21d. 01h. 38·6m., η Taur. (*R*); Nov. 24d. 0h. 04·4m., 87 B. Gemi. (*R*). *D* and *R* refer to disappearance and reappearance, respectively. The Leonid meteors are due about November 16–17, but moonlight will partly interfere with the observations; this shower is very weak and supplies comparatively few meteors now. The Andromedid meteors are due about November 28, and this shower also is very weak compared with what it was in previous years. A transit of Mercury over the sun's disk on November 14 is partly visible at Greenwich: for the ingress, the exterior contact occurs at 15h. 35m. 42s., U.T., and interior contact at 15h. 39m. 12s.; the egress is not visible in the British Isles.

Announcements

Dr. P. H. Gregory, mycologist to the Plant Pathology Department at Rothamsted Experimental Station, has been appointed to the University of London chair of botany tenable at the Imperial College of Science and Technology, in succession to Prof. W. Brown, who is retiring.

Prof. W. T. Astbury, professor of biomolecular structure in the University of Leeds, has been awarded a medal by the American Society of European Chemists for his outstanding contribution to international scientific relations.

Sir Noel Ashbridge, director of technical services of the British Broadcasting Corporation, has been made an honorary member of the British Institution of Radio Engineers, in recognition of his notable contributions to the whole field of radio engineering.

Dr. W. A. Jenkins, director of studies in the University College of North Staffordshire, has been appointed vice-chancellor of the University of Dacca.

Mr. H. C. Pritchard, recently chief superintendent of the Long Range Weapons Establishment in Australia, and formerly head of the Instrument and Air Photography Department of the Royal Aircraft Establishment, has been appointed deputy general manager in charge of science in the firm of Elliott Brothers (London), Ltd.

The new laboratories of the British Iron and Steel Research Association at Hoyle Street, Sheffield, are to be opened by the Duke of Edinburgh on November 19. The laboratories include those of the Cutlery Research Council. Applications for invitations to inspect the laboratories on November 20 should be made in writing to Max Davies, B.I.S.R.A., 11 Park Lane, London, W.1, by November 10.

The following lectures are announced in the programme for November and December issued by the Royal Society: Leeuwenhoek Lecture, by Dr. K. M. Smith, on "Some Aspects of the Behaviour of Certain Viruses in their Hosts and of their Development in the Cell" (November 5); Ferrier Lecture, by Sir Francis Walshe, on "The Contribution of Clinical Observation to Cerebral Physiology" (December 10). Mr. A. H. Wilson will deliver a lecture on the Research Department of Courtaulds, Ltd., on November 12. The Parsons Memorial Lecture for 1953 is being arranged by the Institution of Electrical Engineers, and will be given on January 7 by Mr. H. Leyburn, on "Continuity of Electricity Supply".

The H. K. Sen Memorial Lecture of the Institution of Chemists (India) will be given this year by Dr. S. Husain Zaheer, director of the Hyderabad Central Laboratories for Scientific and Industrial Research and professor and head of the Department of Chemical Technology, Osmania University.

The National Institute of Agricultural Botany will hold a crop conference in Cambridge during December 15–16 on the lines of the one held last year. The subjects to be discussed will include barley varieties, quality in wheat and sugar beet. Further particulars can be obtained on sending a stamped (1½*d.*) addressed envelope to the Secretary, N.I.A.B., Huntingdon Road, Cambridge.

To mark the first anniversary of the death of the late President Chaim Weizmann, a number of scientific events will take place in Israel at the Weizmann Institute of Science during November 2–6. The new building of the Biological Institute will be officially opened and the corner-stone of the Physics Institute laid. Symposia will be held on various subjects connected with biology, biochemistry, polymers and physics. Further information can be obtained from the Academic Secretary, Department of Mathematics, Weizmann Institute of Science, Rehovoth, Israel.

IONIZATION PHENOMENA IN GASES

THE Physical Society, the Institute of Physics and the Electrical Research Association were the sponsors of the first international conference on "Ionization Phenomena in Gases", held at the Clarendon Laboratory, Oxford, during July 18–23. The 250 visitors included many distinguished foreign guests from ten countries. Social activities were held over the week-end, beginning with a reception at Christ Church at which Lord Cherwell and Sir John Townsend were present. There were conducted tours of Oxford colleges and a garden party given by the British Council for overseas visitors. Later in the week ladies visited Blenheim Palace, a blanket mill at Witney and the theatre at Stratford-upon-Avon. Receptions were also given by the British Electricity Authority, and by the Mayor of Oxford.

The conference was opened by Dr. A. von Engel, who surveyed the work in Great Britain. The delegates were also welcomed by Mr. T. C. Keeley, director of the Clarendon Laboratory. Chairmen at the sessions were, respectively: Dr. S. Whitehead, Dr. C. Sykes, Mr. R. Davis, Mr. E. W. B. Gill, Dr. E. J. Bowen, Sir John Cockcroft, Dr. T. E. Allibone and Prof. R. Whiddington.

The main subjects discussed were spark, arc, glow and high-frequency discharges, Geiger counters and several fundamental processes.

There were two schools of thought on the formation of sparks: one ascribing their development to photo-electric action in the gas aided by multiplication in the electric field; the other to secondary processes at the cathode again aided by Townsend multiplication. In support of the first, J. D. Craggs (Liverpool) gave measurements of the rate of the radial expansion of spark channels at high pressure. He discussed how closely thermal equilibrium is attained in the spark channel and noted the observed differences in the 'excitation temperatures' of the various emission lines. J. M. Meek and R. F. Saxe (Liverpool) showed from their measurements on sparks up to 100 cm. long how streamers grow in time and space just before a final breakdown.

The other idea is that Townsend's theory adequately describes all the conditions leading to breakdown, and applies equally to low and high pressures. F. Llewellyn Jones (Swansea) reviewed this theory and showed that, with extremely stable cathode conditions and electric fields, ionization currents increase with distance as predicted by Townsend. This is true even when pressure is greater than 760 mm. mercury and up to voltages approaching the breakdown value. In the discussion, he suggested that in impulse fields, luminosity, which depends on high ion density, may appear at the anode, later moving quickly towards the cathode. C. Grey Morgan (Swansea) stressed the importance of field emission caused by surface layers on metal cathodes.

L. H. Fisher (New York) described the marked effect of excess voltage on the formative time lag. When the voltage is just above threshold, the lag is about 10^{-4} sec. in air, nitrogen, argon and oxygen. This again supports Townsend's theory and points to photoelectric emission at the cathode, except in argon, where there is a long delay even at high excess voltages, probably due to imprisonment of resonance radiation. C. E. R. Bruce (Electrical Research Association) pointed out that breakdown fields in air for extremely long gaps (for example, between clouds and earth) are about 100 V./cm., which shows that the starting process must be different from that with uniform fields and metal electrodes. Corona currents which flow radially outwards from streamers were mentioned, and certain solar eruptions were likened to long sparks.

In the session on arc discharges, R. Mannkopff (Göttingen) discussed radiation equilibria. By examining spectral intensities he showed that after an arc is switched off, thermal excitation and ionization persist, and must have predominated previously. Auto-ionization appears to be a probable process. W. Lochte-Holtgreven (Kiel) described high-power arcs in water vapour giving temperatures of about 50,000° K. The electron concentration is determined by the equation of Inglis and Teller, after observing the number of Balmer lines of hydrogen visible. The continuous background is partly caused by negative atomic hydrogen ions. H. Maecker (Erlangen) showed how, by varying the pressure in such arcs between 100 and 1,000 atmospheres, one can discriminate between, and measure, the cross-sections for electrons colliding with neutral atoms and positive ions. M. Hoyaux (Charleroi) described the use of Ledrus's 'plasmograph', recording Langmuir's probe characteristics in mercury rectifier discharges with a time resolution of less than 20 microsec.

P. F. Little (Oxford) opened the session on glow discharges by describing how the electric field distribution in a hollow cathode discharge in nitrogen can be measured. The deflexions of an electron beam show a linear fall of field with distance from the cathode down to very small values at the boundary of the glow. The large current density observed is explained by a large ion concentration and ion-drift velocity. He concluded that many electrons are emitted from the cathode by light from the intense glow. W. Fucks (Aachen) has used corona discharges to measure aerodynamic effects, notably the appearance of vortices, and the associated flow of gas. W. L. Harries (Oxford) discussed the abnormally low starting fields in high-frequency electrodeless discharges in neon; he attributes them to the production of a large concentration of excited atoms which are later ionized by low-energy electrons released by light from the glass walls. G. Valle (Bologna) has applied relaxation oscillations of increasing frequency to a discharge in argon or neon. The restriking potentials decrease when the residual ionization from the afterglow becomes important. W. A. Prowse (Durham) showed that in microwave discharges ionization is due to electron collisions and loss to diffusion. With short pulses, however, a critical electron density has to be reached within the pulse-time to obtain breakdown. In polyatomic gases, a formative lag of less than 10^{-8} sec. is observed. It is suggested that the oscillating electrons produce excited molecules which are readily ionized. This idea is being tested by applying an auxiliary D.C. electric field at right angles which drives the electrons into unexcited gas. Oscillograms of the current in pulsed high-frequency electrodeless discharges were presented by G. Francis (Oxford), who discussed the mechanism of growth of current. He showed that in hydrogen two secondary processes, one fast and one

slow, are necessary. S. C. Brown (Massachusetts Institute of Technology), injecting electrons into a low-pressure mercury plasma, observed plasma oscillations only when ion sheaths were present around the electrodes. Their frequency depended on the density of the electrons which oscillate in certain standing-wave forms. From the variation of the frequency with the thickness of the sheath, it follows that a 'transit-time process' causes these oscillations. D. C. Dalton (London) reported experiments which indicate the effect of space charges on the breakdown of high-frequency discharges in air.

In the following session, G. L. Weissler (Los Angeles) described his vacuum spectrographic measurements in rare and molecular gases, which yield the absorption coefficients as a function of the wave-length and thus the photo-ionization cross-sections. Preliminary results have also been quoted of photoelectric yields on various metal surfaces, again for wave-lengths between 100 and 1000 A. In the discussion, W. B. Nottingham (Massachusetts Institute of Technology) mentioned some results obtained with pure silica. P. J. Jutsum (Reading) compared his experimental results of photo-ionization cross-sections in sodium, magnesium, calcium and thorium vapours with the calculated values and described a method of discriminating between molecular and atomic absorption. In a written communication, A. and E. Vassy (Paris) described the character of spectra of sparks in air of 15–150 cm. length ; a study of the spectral lines as a function of the time has also been made. G. Valle (Bologna), in a paper read by R. W. Lunt, described his theory of breakdown in a transverse magnetic field. This field is supposed to have the same effect as an increase in density of gas. Assuming only inelastic collisions with electrons of constant mean free path, he obtains results which agree roughly with experiments. J. M. Somerville (Sydney), extending this theory, included the distribution of free paths and the partial capture of electrons driven back to the cathode by the field. He also described the effect of transverse fields on the length of the dark space in glow discharges between concentric cylinders.

In the session on counters, R. Loosemore (Harwell), in a paper read by W. Abson, discussed certain features of the bromine-quenched counter. At a critical voltage a second pulse appears, due to another discharge between ion sheath and cathode. The probable origin of spurious oscillations was also discussed. P. J. Campion (Oxford) showed cloud-chamber photographs of the propagation of a Geiger discharge along a counter wire in an air–alcohol mixture ; the charge distribution within the ion sheath was measured. H. den Hartog (Amsterdam) spoke about the electron component in the Geiger discharge, which he thinks may be explained by the large radius of the space charge at high excess voltages. A group of Italian workers, L. Colli, U. Facchini, G. Bertolini and others (Milan), presented papers on the mechanism of argon-filled counters. α-Particles were used to trigger light and electron current pulses which were observed simultaneously. The light pulse lasts longer, due to the long life of metastable argon atoms and excited molecules. Current oscillograms from counters with nickel or brass cathodes show that their photoelectric yield must be of the order of 10^{-2}. Ionization currents in argon with small amounts of polyatomic gases were found to differ from those theoretically expected. This is sometimes due to interaction between the components of the mixture, sometimes to ionization by δ-rays (slow electrons).

High-vacuum studies were introduced by R. L. Fortescue (London), who talked about breakdown in highly evacuated gaps. Bursts of current precede the development of an arc and depend on the condition of both electrodes. J. W. Leech (London) presented calculations on these pulses, assuming that the electrons are confined to narrow channels, and estimated the gas pressure necessary to make them diverge. D. Alpert (Pittsburgh) reviewed the existing ultra high-vacuum technology and described new methods of obtaining a pressure so low as 10^{-10} mm. mercury without getters or refrigerants. S. Wagener (General Post Office, London) showed that the high gettering rates of barium can only be understood by assuming that the reacting gas particles are atoms, not molecules. Selective getters were also treated. J. H. Mason (Electrical Research Association) showed oscillograms and Lichtenberg figures of pulse-discharges in cavities in dielectrics when subjected to low-frequency fields and offered tentative explanations.

In the last session, R. Geballe (Seattle) described simultaneous measurements of ionization and attachment coefficients and discussed quantitatively the effect on the ionization current as a function of the electrode separation. N. L. Oleson (Monterey) presented preliminary work using Langmuir probes and photomultipliers for measuring simultaneously charge density and light from striations in an argon positive column. Kantrowitz (Cornell) reported measurements on ionization and light produced in argon and in argon–oxygen mixtures by shock waves.

A. VON ENGEL
G. FRANCIS

GROUP DISCUSSION

IN view of the increasing use which is being made of discussion groups as an educational medium, the editors of the *Health Education Journal* are to be commended for devoting the whole of a recent issue to the subject of group discussion (**11**, No. 3 ; July 1953). The theory of group discussion is introduced by Dr. M. L. Johnson, who suggests that the disadvantage of the lecture as a teaching method is that there is no 'feed-back' to the teacher ; he cannot know what is selected or how what is absorbed is distorted. He can only try to present the material in a manner which, from his judgment of the listeners' backgrounds, he considers interesting and unambiguous, so that they will absorb as much, and in as undistorted a form, as possible. This disadvantage does not apply to the discussion method ; but, to be successful, discussion must be carried out in a "permissive atmosphere". This is essential because people must not be allowed to feel afraid of making fools of themselves by exposing the irrationality of their thinking and feeling. They must feel free to talk in a spontaneous, even incoherent and random manner, so that assumptions can be brought to light and their usefulness examined.

The means of introducing discussion is examined by Dr. Emrys Davies, who indicates that, in most cases, discussion is educational in character because almost invariably it aims at modifying attitudes and changing behaviour. To be fully effective the leader of the discussion group should devote considerable time to preparation before meeting his group. Besides

getting to know the background of his group, the theme chosen for discussion should have meaning and purpose in their lives.

The technique of running a successful discussion group is elaborated by Mrs. Margery Fassam, who considers that group discussions for training or teaching were introduced on the assumptions that we all have something to learn from each other, and that active participation in a teaching–learning session achieves better results through this co-operation than a straight lecture. By a process of questioning and discussing, the group can thoroughly explore a subject, and in this process the sum total of the knowledge and experience of the group comes into play. Ideas are modified by coming into contact and sometimes conflict with other ideas. Mrs. Fassam also gives some useful practical hints on the ways of conducting discussion groups, while Dr. Paul Polani writes of his experience in using organized discussion for investigating social problems in the pædiatric curriculum at Guy's Hospital Medical School, London.

The place of the discussion group as a potent force in health education is well brought out by Dr. John Burton, the medical director of the Central Council for Health Education, who also describes the film strips which his organization has produced for use with discussion groups.

The greater use of discussion groups in industry is advocated by J. J. Gillespie, who believes that small free discussion groups meeting regularly in paid time with participation by all primary workers within a business may be a remedy for the lack of personal significance and self-expression experienced by these workers in modern business organizations. While serving this purpose, the discussion groups are a likely way of healing the breach between work life and leisure life, and of solving the problem of relationships in work. Such discussion groups are already in existence in some firms and have proved worth while.

The final article has been written by Magda Kelber, a refugee in Britain during the War and who has now returned to Germany to become the head of Haus Schwalbach, a leadership training centre. The methods in use at Haus Schwalbach have been based on principles developed by Mrs. Rachel DuBois in the United States. These sprang from the need for integrating many different elements of racial, national and religious background in local communities which have their own patterns and their own sets of values and prejudices. Such a collection of people was found in Germany after the War, and Magda Kelber describes how the principles were adapted to meet local needs and interests.

HETEROSIS IN SACCHAROMYCES

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FOUR different genes have been described in *Saccharomyces* which control the hydrolysis of alpha-glucosides, each gene producing a specific and different enzyme[1,2] (Table 1).

Table 1

Gene	Enzyme	Substrate
MA	Maltase	Maltose and turanose
MG	Alpha-methyl glucosidase	Alpha-methyl glucoside
SU	Invertase	Sucrose and raffinose (1/3)
MZ	Alpha-gluco-melezitase	Maltose, turanose, sucrose, alpha-methyl glucoside, and melezitose
?	Gluco-sucrase	Sucrose (not raffinose)

A culture of genotype *MA mg su mz* can grow on maltose and produce the adaptive enzyme maltase, but is incapable of growing on or adapting itself to alpha-methyl glucoside, sucrose, raffinose or melezitose[3]. A culture of genotype *ma MG su mz* can grow on alpha-methyl glucoside, but is incapable of fermenting any of the other alpha glucosides. The fact that alpha-methyl glucoside acts as the inductor of the enzyme alpha-methyl glucosidase is curious, since alpha-methyl glucoside is not a natural substrate and the ability to hydrolyse alpha-methyl glucoside is of no survival value. Hestrin and Lindegren showed that the culture of genotype *MA MG su mz* produces (in addition to maltase) alpha-methyl glucosidase (and gluco-sucrase) during growth on maltose, but neither invertase nor alpha-gluco-melezitase. This phenomenon was called heterologous adaptation[4]. The present article deals with the interactions of the *MA* and *MG* genes in diploid hybrids. The hybrids were made with haploids recessive for the genes controlling the production of invertase and alpha-gluco-melezitase to avoid the complications which would ensue because of the production of alpha-gluco-melezitase and invertase.

Methods. The haploids used for making the hybrids were *MA MG* (4), *MA mg* (2), *ma MG* (1) and *ma mg* (2). The different types of hybrids are listed in Table 2.

Table 2

	MA MG (4)	*MA mg* (2)	*ma MG* (1)	*ma mg* (2)
MA MG	$\frac{MA\ MG}{MA\ MG}$ (4)	$\frac{MA\ MG}{MA\ mg}$ (1)	$\frac{MA\ MG}{ma\ MG}$	$\frac{MA\ MG}{ma\ mg}$ (2)
MA mg		$\frac{MA\ mg}{MA\ mg}$	$\frac{ma\ MG}{MA\ mg}$ (1)	$\frac{MA\ mg}{ma\ mg}$ (1)
ma MG			$\frac{ma\ MG}{ma\ MG}$	$\frac{ma\ MG}{ma\ mg}$

Five kinds of hybrids were tested. The data appear in Table 3. All the haploids or hybrids carrying both the *MA* and *MG* gene showed the phenomenon of heterologous adaptation, but other cultures lacked this characteristic.

The cultures were grown on complete media containing (*a*) maltose or (*b*) alpha-methyl glucoside as the only added sugar, and harvested and tested for their rates of fermentation of glucose, maltose, alpha-methyl glucoside, sucrose, raffinose and melezitose. All tests on raffinose and melezitose were negative, showing that the cultures carried *su* and *mz* instead of their dominant alleles. Nitrogen was determined directly by a Nessler test. All cultures (with three exceptions) fermented glucose at rates of 2,000–3,800 $Q_{CO_2}^{N_2}$ (N).

In calculating the Q values (which are based on carbon dioxide evolved), those for maltose and sucrose were divided by 2 to equate them with those for alpha-methyl glucoside. Because alpha-methyl glucosidase liberates only a single molecule of hexose whereas maltase and gluco-sucrase each liberate two molecules of hexose, and because the rate of evolution of carbon dioxide is used as the measure of enzyme,

Table 3

Culture No.	Genotype	Cells grown on maltose: Cells tested on glucose	maltose	α-methyl glucoside	sucrose	Cells grown on α-methyl glucoside: Cells tested on glucose	maltose	α-methyl glucoside	sucrose
8,324	*MA MG*	2,631	474	447	126				
		2,962	455	400	45	2,346	0	1,061	0
15,198	*MA MG*	2,246	179	267	82	2,959	0	2,678	21
15,191	*MA MG*	2,389	649	285	0	1,818	0	589	0
8,282	*MA MG*	2,680	440	280	0	3,010	0	1,677	0
14,268	*MA mg*	2,575	538	0	0	—	—	—	—
14,262	*MA mg*	1,064	82	0	50	—	—	—	—
		1,340	119	0	0	—	—	—	—
14,716	*ma MG*	—	—	—	—	680	0	755	0
		—	—	—	—	2,700	0	1,895	0
8,282 / 8,324	*MA MG* / *MA MG*	3,500	910	646	0	2,765	0	2,545	0
		3,010	907	717	0				
15,198 / 8,256	*MA MG* / *MA MG*		712		0	2,916	0	2,851	0
15,289 / 15,191	*MA MG* / *MA MG*	3,136	592	404	210	2,745	0	1,626	0
15,289 / 8,282	*MA MG* / *MA MG*					3,092	0	1,238	0
15,289 / 14,268	*MA MG* / *MA mg*	2,400	850	460	0				
14,262 / 14,716	*MA mg* / *ma MG*	2,066	163	175	23	2,344	0	567	0
		2,056	194	436	30	2,786	0	1,956	37
8,324 / 15,214	*MA MG* / *ma mg*	2,100	1,292	258	564	2,442	0	1,920	0
		3,846	988	317	176				
15,214 / 15,198	*ma mg* / *MA MG*	2,700	649	475	99	2,527	0	2,449	37
14,268 / 15,214	*MA mg* / *ma mg*	2,067	309	0	0	—	—	—	—

this correction equates the amounts of the three enzymes. No adaptations produced maltase in excess of the capacity of the cell to consume the glucose produced.

Results. Only those haploids or hybrids carrying the *MG* gene were able to grow on the medium containing alpha-methyl glucoside. Cells grown on alpha-methyl glucoside varied in ability to ferment alpha-methyl glucoside with Q values of 500–2,800. Four of fourteen fermented alpha-methyl glucoside and glucose at practically the same rate, suggesting that the alpha-methyl glucosidase was in excess of the capacity of the cell to utilize all the glucose made available by hydrolysis of alpha-methyl glucoside. None of the cultures grown with alpha-methyl glucoside was able to ferment maltose.

Only cultures carrying the *MA* gene were able to grow on the medium containing maltose. The $Q^{N_3}_{CO_2}$ (N) on maltose of haploid cultures grown on maltose and carrying the *MA* gene varied between 200 and 600. Culture 14,262 was much weaker but exhibited a generally low metabolic activity, since its activity on glucose was less than half that ordinarily shown.

The amount of alpha-methyl glucosidase produced by cells grown on maltose as a result of heterologous adaptation was always less than the amount produced by homologous adaptation.

Heterosis. All hybrids carrying either *MG/MG* or *MG/mg* were more active in fermenting maltose than the haploids from which they were produced, in spite of the fact that in the hybrids heterozygous for *MA* the gene 'concentration' for *MA* is reduced by one-half. Hybrid 14,268 × 15,214 *MA mg/ma mg* (homozygous for *mg/mg*) had a Q value for maltose of 309, while the haploid parent (*MA mg*) had a higher value, namely, 538. The value for the hybrid (*MA/ma*) is approximately equivalent, on a gene basis, since the *MA* 'concentration' of the hybrid is one-half that of the haploid. Since the diploid cell is twice as large as the haploid, the *MA* 'concentration' in the haploid cytoplasm is twice as great as in the diploid. These results show that no special quality is conferred by hybridization, and that the hybrid is not *ipso facto* superior to the parent.

The average Q value of the maltose-grown haploids on maltose was 395, whereas the average Q value of the maltose-grown hybrids on maltose was 719, excluding 14,268 × 15,214. Many of the hybrids were heterozygous for *MA/ma*, thus reducing the 'concentration' of the *MA* gene by one-half; but in spite of the reduction in concentration, the increase in fermentative ability was spectacular. For example, haploid 8,324 (*MA MG*), with a Q value of 465 on maltose, was mated to 15,214 and produced a hybrid (*MA MG/ma mg*) which achieved a Q value on maltose of 1,140, an increase of nearly threefold on a nitrogen basis, and nearly sixfold on a gene basis. Hybrid 15,198 × 15,214 was also superior to 15,198, rising from a level of 179 in the haploid to 649 in the hybrid. In the absence of the *MG* gene, culture 15,214 does not confer any special improvement on the hybrid; this was shown in the analysis of the hybrid 14,268 × 15,214 (*MA mg/ma mg*).

The average Q value of the haploids grown on maltose tested on alpha-methyl glucoside was 314, whereas the average value of the hybrids was 402, although several hybrids were heterozygous for *MG/mg* and, therefore, carried a reduced concentration of the *MG* gene.

The data also indicate that the ability to produce gluco-sucrase is enhanced in the hybrids. The hybrid which failed to show an increase in maltase production produced neither alpha-methyl glucosidase nor gluco-sucrase.

Conclusions. The data suggest that the increase in maltase in the hybrid is due to a group of modifying

genes of which *MG* is the principal member. A member of this group, different from *MG*, is present in 15,214, and may be inferred to have some effect on the production of gluco-sucrase. Although the *MA* gene alone can control the production of maltase, it functions much more effectively in concert with other genes, one of which effects the production of alpha-methyl glucosidase, while another may produce gluco-sucrase. *MG* is distinguished by its ability to react adaptively to alpha-methyl glucoside to produce alpha-methyl glucosidase. Although this enzyme has no biological value in terms of its ability to hydrolyse alpha-methyl glucoside, it may be involved in the synthesis of maltase. In the absence of *MA*, *MG* is incapable of responding to maltose. Lindegren[2] has inferred that the gene *MZ* is a receptor on which substrate acts to produce an impulse which finally results in the production of alpha-gluco melezitase. Assuming that *MA* (which appears to be closely related[5]) acts similarly, the effect of *MG* on *MA* may be to enhance the impulse from the *MA* locus to the site of enzyme production. In the presence of *MG*, the impulse from *MA* induced by maltose may result in the elicitation of alpha-methyl glucosidase, some of which can be converted into maltase. Another locus may cause the *MA* impulse to elicit gluco-sucrase, which is possibly convertible into alpha-methyl glucosidase.

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PHYSIOLOGICAL RACES OF WHEAT STEM RUST IN EGYPT*

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WHEAT stem rust is considered the most important disease which attacks this crop and the greatest hazard in its production. In Egypt this rust attacks the Hindi varieties (*Triticum vulgare*) and durums (*Triticum durum*), while Baladi varieties (*Triticum pyramidale*) are nearly immune. The loss caused by this rust to the Hindi varieties is estimated at about 500,000 erdebs (1 erdeb = 150 kgm.), which is worth about 2 million Egyptian pounds.

In normal years the damage caused by stem rust on the Hindi varieties is about 10 per cent of the total crop. Most of the damage occurs in lower Egypt (the Delta of the Nile) because of the high humidity which prevails in that area. About one million feddans (1 feddan = 1·038 acres) are cultivated with wheat in this area. In Upper Egypt, where about half a million feddans of wheat are grown, the severity of rust attack is less important.

Physiological specialization of *Puccinia graminis tritici* Eriks. and Henn., the causal organism of wheat stem rust, was first reported by Stakman and Peimisel in 1917. The first investigations on the specialization of this rust in Egypt were carried out by the writer in 1949.

The main object of the present investigation has been to identify the physiological races of *Puccinia graminis tritici* Eriks. and Henn. in Egypt and to study their geographical distribution all over the country. It was found desirable to study also the reaction of a great number of wheat and barley varieties to the existing races.

Such study may contribute information about the physiological races existing in Egypt and probably in other parts of the Middle East which may help in using these races in the breeding programme for rust resistance. On the other hand, identifying the races may help in tracing the movement of the urediospores of stem rust from one country to another and consequently shed some light on the proper materials to be exchanged among these countries for breeding for rust resistance.

Experimental Results

Identification of physiological races. Rust specimens were collected every year during April and May from different varieties of wheat grown in various localities and provinces of Egypt and were stored in the refrigerator during summer-time until the temperature became suitable inside the greenhouses for working on the identification of physiological races. The differential varieties and the method of identification used in this investigation are those used by Stakman.

In 1949 about seventy-four rust collections were used for race identification and about 253 isolates originated from these collections. Nine races of *Puccinia graminis tritici* Eriks. and Henn. were isolated. These races are 9, 14, 17, 19, 21, 24, 42, 88 and 123. A new race which is similar to race 17 was isolated in 1949 from a rust specimen collected from an unknown variety of wheat grown at Menshat Sultan, Dakahlieh. The reaction of the differential varieties to this race is similar to those of race 17 except that Acme is resistant to this new race. It was given the symbol E_1 (Egypt No. 1). Race 17 was the most prevalent one in that year. It was found in 47·85 per cent of the total isolates. Race 21 came second, race 19 third, and race 14 fourth, while other races were less frequent.

The work of 1950 on forty-four rust collections, giving rise to 170 isolates, revealed the existence of eight races of *Puccinia graminis tritici* Eriks. and Henn., namely, 9, 14, 17, 19, 21, 24, 42 and 53. Again race 17 was the predominant race. It was found in 43·5 per cent of the total isolates. With regard to the other races there was fluctuation in their prevalence in comparison with the results of the previous year. Race 19 was the second, race 42 the third, while race 21, which was the second in 1949, became the fourth in 1950. The other races were also of minor importance in 1950.

In 1951 identification of physiological races was handicapped by unforeseen circumstances. On account of this, only nine rust collections were good to work with. About seventeen isolates were made, giving rise to races 17, 19, 42 and 59 of *Puccinia graminis tritici* Eriks. and Henn. Despite the small number of rust isolates in 1951, race 17 was the most prevalent race. Race 59 was isolated for the first time in Egypt from a rust sample collected from a Hindi variety of wheat grown at Desouk, Fouadieh.

* Substance of a paper presented at the Second Conference of Wheat Breeding in the Near East, held in Cairo during March 13–18.

In 1952 race 17 was also the predominant race. Race E_1 appeared again and was isolated from a rust specimen collected from the variety Giza 139 grown at Behtim Farm of the Royal Agricultural Society.

It is desirable to demonstrate here that race 17 was isolated from all the rust specimens which were collected from several varieties of wheat grown in Cyprus and which were sent by D. K. Jones. Race 19 was isolated from one of these specimens.

It can be concluded that twelve physiological races of *Puccinia graminis tritici* Eriks. and Henn. were found thus far in Egypt. They are races 17, 19 21, 42, 14, 9, 24, 59, 88, 53, 123 and E_1, arranged according to their prevalence.

Reaction of wheat varieties to different races. In this study a great number of wheat varieties and strains produced locally or imported from other countries were tested for their reaction to the most prevalent races. In 1949 about 237 varieties were inoculated in the seedling stage with races 14, 17, 19, 21 and 42. It was found that fifty-nine varieties are resistant to these five races; forty-nine resistant to some of them and susceptible to the others; and 129 susceptible to all five races.

In 1950 about thirty-seven varieties and strains of wheat were tested, and the results obtained show that twenty of them are resistant to races 9, 14, 17, 19, 21 and 42 of wheat stem rust, thirteen resistant to some of these races and susceptible to the others, and four susceptible to all of these races.

During 1951 about seventy-four varieties and strains of wheat were inoculated with races 17, 19, 21, 24 and 42 in the seedling stage in the greenhouses, as well as in the adult stage in the rust nursery. The seedling stage reaction showed that forty-three of these wheat varieties were resistant to the above-mentioned races, sixteen resistant to some races and susceptible to the others, and fifteen susceptible to these races. In the adult stage it was found that all the varieties and strains which were resistant in the seedling stage retained their resistance in the adult stage except the variety Bobin-Gaza-Bobin, which was moderately susceptible. On the other hand, all the susceptible varieties in the seedling stage were also susceptible in the adult stage except one line of a cross between Giza 139 and *N.A.* 480, which was resistant in the adult stage.

In 1952 about sixty-six varieties and strains of wheat were tested for their reaction to races 9, 14, 17, 19, 21, 59 and E_1 in the seedling stage. It was found that forty-two were resistant to these seven races; nine resistant to some of them and susceptible to the others; and fifteen susceptible to all seven races.

From the reaction of this large number of varieties and strains of wheat to races 9, 14, 17, 19, 21, 42 and E_1, and the number of susceptible varieties to each race, it can be concluded that race 9 is more virulent than the other races, followed by races 21, 17, 19, 14, 42, 59 and E_1, arranged according to their relative virulence.

It is worth mentioning in this respect that the majority of the strains which showed resistance in the above-mentioned investigation were promising lines produced locally by hybridization with some of the introduced varieties. This is in contrast with the large number of these introduced varieties which were highly susceptible under Egyptian conditions, and as such were discarded from the breeding programme.

STRUCTURE OF AIR-DRY SODIUM THYMONUCLEATE

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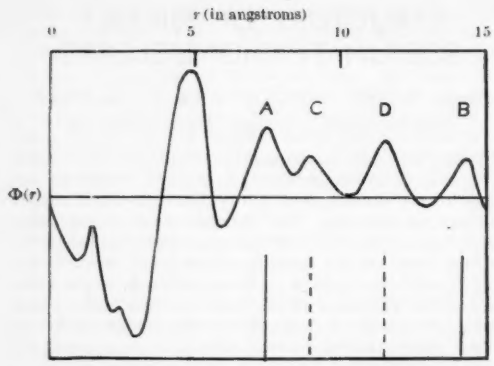
RECENT stereo-chemical considerations[1,2] and X-ray investigations[3,4] on the structure of deoxyribose nucleic acids have established with a fair amount of certainty that the structure of the polynucleotide chain is a helical one, with the phosphate groups lying on the outside of the helix and the flat sugar and base groups pointing towards the central axis. The diameter of the helix on which the phosphate groups lie is estimated to be about 20 A. It seems likely that the complete molecule is made up of two such helices coiled about a common axis.

Experimental studies which confirm this model have so far been confined to specimens having as high a degree of order as possible and which, therefore, have a high water content. We have thought it interesting to investigate whether any information could be derived from nucleic acids in the form of their sodium salts in an air-dry amorphous condition (*c.* 30 per cent water-content by weight) by studying their radial distribution curves. The amount of information obtainable in this way is necessarily much more limited than that afforded from oriented specimens or even from cylindrical Patterson functions and is less capable of a unique interpretation.

When a radial distribution curve is derived from the X-ray scattering curve produced by an unoriented specimen in the usual manner[5], the resultant function shows a multitude of peaks characteristic of all possible interatomic distances. When the substance investigated is a complex one in which the great majority of the atoms in the structure have similar atomic numbers, as for example in a protein, it is generally not possible to obtain any direct information from the radial distribution curve owing to its complexity. Significant results can, of course, be obtained in many cases by means of a comparison of the experimental radial distribution curve calculated from a detailed model.

The situation becomes more advantageous when the molecule under investigation contains some atoms, or groups of atoms, much heavier than the remainder, and when these groups are suspected to be arranged in a regular manner in the structure. The weight of interatomic vectors in a radial distribution function, as in a Patterson function, is the product of the number of electrons in the pair of atoms, and peaks corresponding to the distances between heavy groups can be expected to stand out and be capable of identification.

In the sodium nucleates the group $NaHPO_2$ can fulfil this role. This group is approximately tetrahedral in shape with the phosphorus at the centre of the tetrahedron, and it seems permissible to identify the prominent peaks in the experimental radial distribution curve with vectors between phosphorus atoms. The function $\Phi(r)$ plotted in the accompanying diagram is the smoothed radial distribution function calculated from the experimental scattering curve from sodium thymonucleate (calf) in the solid, air-dry state after multiplying the latter by an artificial 'fade-off' or temperature factor $\exp(-Bs^2)$, where $s = 4\pi\sin\theta/\lambda$ and $B = 0{\cdot}1$. The effect of this factor is to suppress the less prominent peaks in the distribution function. A curve calculated without the



Radial distribution curve from air-dry sodium thymonucleate

aid of this device (not reproduced) shows the same main features in the range 0–15 A. At values of r greater than 15 A. the smoothed curve shows no prominent peaks with the exception of one at about 28 A.; but in view of the nature of the numerical Fourier inversion process employed, it is doubtful whether this has any reality or whether it is merely an artefact.

The first peak at 1·45 A. agrees well with the distance between nearest neighbours in any organic structure, while the second peak at about 2·6 A. may be regarded as a mixture of the average distance between second-nearest neighbours (*c.* 2·5 A.) and the P—Na distance in the phosphate group (*c.* 2·9 A.). If the two-helix hypothesis[2] is adopted, the number of possible ways of interpreting the next peaks as intra- and inter-helix peaks is very limited. There is no way of coiling a polynucleotide chain in such a way as to make the nearest neighbour intra-helix vectors 5 A. and at the same time to make the second-nearest neighbour vector coincide with one of the following peaks. If one of the peaks at a value of r greater than 7·4 A. is assumed to represent the first intra-helix vector, too large and open a molecule would result and, in fact, the only reasonable combination of nearest and second-nearest neighbour P—P vectors is obtained by making these the peaks *A* and *B*, respectively, at 7·4 A. and 14·3 A. Considerable latitude exists in the dimensions of a helix to fit these values, but it cannot be outside the following limits:

Radius of helix	= 11 ± 1·5 A.
No. of residues per turn	= 11 ± 2
Fibre-axis repeat per residue	= 2·4–3·4 A.

Interpretation of the 5-A. peak as being the closest approach between helices 1 and 2 would explain the 9-A. peak *C* as being due to the vectors from a phosphate group on helix 2. The objections to this model are that the prominent peak *D* at 11·5 A. cannot then be interpreted and that the fibre axis component of the interchain distance would be only 4·45 A.

Alternatively, the position of helix 2 can be chosen so as to interpret peaks *C* and *D* as the vectors from phosphate groups on helix 1 to the nearest and second-nearest phosphate groups, respectively, on helix 2. The fibre-axis separation between the two helices is then 8·5 A. and becomes approximately a quarter to a third of the fibre-axis repeat. The prominent 5-A. peak must now be due to the combination of a large number of vectors between lighter atoms. This assumption seems justified, since the radial distributions of many organic polymers not containing heavy atoms, for example, globular proteins, β-proteins and collagen[7], and nylon[8a], 'Perspex'[8b] and cellulose[8c] have a peak in this region. It should be noted that this peak is of a different height from peaks *A*, *B*, *C* and *D*, while the P—P vectors in a long molecule would all have the same weights. In the diagram, the full lines are the intra-helix P—P vectors and the broken lines the inter-helix vectors calculated for a helix of radius 10·6 A. with ten residues per turn of 34 A. The second helix is displaced by 8·5 A. along the axis relative to the first in such a way as to make the inter-helix vectors as short as possible. In this model the line joining the two phosphorus atoms on the two helices which are pictured as being bridged by their bases[2] is inclined to the horizontal at an angle of about 15°, the two phosphate groups being 21 A. apart.

The above arguments alone do not uniquely define a specific model; we have not, for example, examined in detail a model of the kind proposed by Pauling and Corey[9] in which the phosphate groups lie near the core of the cylindrical molecule; it would appear that such a molecule would show little except a strong peak at 5 A. Nevertheless, it is of interest that an easy interpretation of the radial distribution function of amorphous air-dry sodium thymonucleate is possible which is in good agreement with the molecular model derived for crystalline nucleic acid.

We wish to thank Prof. J. A. V. Butler and Mr. P. F. Davison for the sample of nucleic acid. The investigation was supported by a grant from the British Empire Cancer Campaign. [Sept. 8.

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CIS-TRANS ISOMERIZATION AND THE CEILING TEMPERATURE PHENOMENON IN POLYMERIZATION

By Prof. F. S. DAINTON and G. M. BRISTOW
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It has been shown previously that the rate of any addition polymerization process should ultimately decrease as the temperature is increased whatever the nature of the dependence of the rate on temperature at low temperatures, provided that the reaction is associated with a decrease in heat content and entropy. Moreover, the reaction-rate should become zero at a 'ceiling' temperature T_c, which is independent of the rate or chemical nature of the initiation reaction. This and related phenomena are due to the reversibility of the propagation reaction, which may be written:

$$m_1 + m_j^* \underset{k_d}{\overset{k_p}{\rightleftharpoons}} m_{j+1}^*, \qquad (1)$$

where m_1, m_j^*, $k_p = A_p \exp(-E_p/RT)$ have their usual significance and $k_d = A_d \exp(-(E_p - \Delta H)/RT)$, the subscript d denoting depropagation (that is, the reverse of propagation), and ΔH is the heat of polymerization. The value of T_c is then given by:

$$T_c = \Delta H/\Delta S = \Delta H/(\Delta S^0 + R \ln [m_1]) = \Delta H \Big/ \left(R \ln \frac{A_p[m_1]}{A_d}\right), \qquad (2)$$

where ΔS^0 is the value of the entropy change accompanying reaction when the monomer concentration is 1 gm.-mol./litre. Polymerization systems exist in which all these expectations may be realized.

It is of interest to extend this theory to the polymerization of 1,2 disubstituted olefines which can exist in geometrically isomeric forms. The isomers will possess different ceiling temperatures, the difference between them at $[m_1] = 1{\cdot}0$ M being:

$$(\Delta H^{cis}/\Delta S^{0\ cis} - \Delta H^{trans}/\Delta S^{0\ trans}).$$

In the special case where the polymers formed from the two monomers are identical, consisting of the same mixture of optical isomerides, two further possibilities arise. First, if the polymers have similar solution properties in each reaction mixture, we may write:

$$T_c^{cis} - T_c^{trans} = \left[\frac{\Delta H^{cis}}{\Delta S^{cis}} - \frac{\Delta H^{cis} + H^{trans} - H^{cis}}{\Delta S^{cis} + S^{0\ trans} - S^{0\ cis}}\right], \qquad (3)$$

and the ceiling temperature of one isomer can be predicted from that of the other provided the differences in heat content and entropy of the isomers are also known. Secondly, since the finished polymer molecules are identical, the growing polymer chains, ionic or free radical, derived from each isomer must also be identical, and it follows that on depropagation these radicals may produce either isomer. From general thermodynamical considerations, it is obvious that the isomers so produced must be in amounts corresponding to equilibrium under the prevailing conditions. Hence at temperatures where depropagation is occurring to any appreciable extent, the polymerization of an initially pure isomer should be accompanied by detectable isomerization. Embodying these processes in equation (1), we obtain equation (4):

$$cis\ m_1 + m_j^* \underset{k_d^{cis}}{\overset{k_p^{cis}}{\rightleftharpoons}} m_{j+1}^* \underset{k_d^{trans}}{\overset{k_p^{trans}}{\rightleftharpoons}} m_j^* + trans\ m_1, \qquad (4)$$

and the initial isomerization-rates of the pure *cis* and *trans* monomers will be $k_d^{trans}\,\Sigma[m_j^*]$ and $k_d^{cis}\,\Sigma[m_j^*]$, respectively. The isomerization should thus be detectable at those temperatures where the polymerization deviates appreciably from the Arrhenius law, and should increase with temperature according to the normal Arrhenius law, that is, show no ceiling temperature.

We have recently tested these predictions by determining the variation with temperature of the rates of interpolymerization of sulphur dioxide with *cis* butene-2 and *trans* butene-2, respectively, and the rates of the concomitant isomerizations. In these systems the monomers concerned may be loose 1 : 1 molecular compounds of the respective olefine and sulphur dioxide. The main conclusions are illustrated in Figs. 1 and 2.

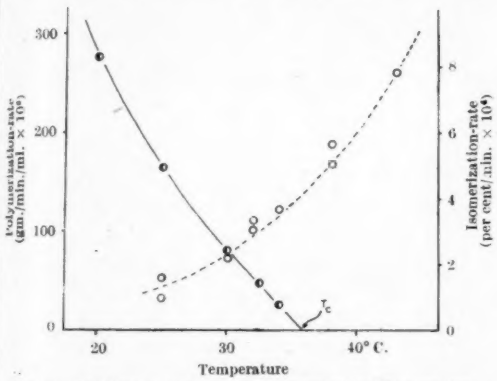


Fig. 1. Full line, ● —●—, photopolymerization; broken line, o—o—, Bz_2O_2 catalysed isomerization (*cis* → *trans*)

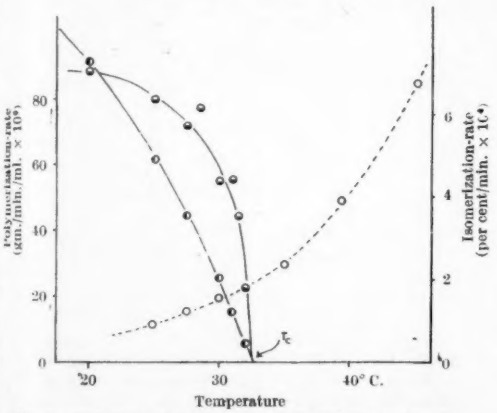


Fig. 2. Full line: ● —●—, photopolymerization; ❍—❍—, Bz_2O_2 catalysed polymerization. Broken line: Bz_2O_2 catalysed isomerization (*trans* → *cis*)

Variation with temperature of the rates of interpolymerization (full lines) of *cis* butene-2 (Fig. 1) and *trans* butene-2 (Fig. 2) with sulphur dioxide; and the initial rates of concurrent isomerization (dotted lines) *cis* → *trans* (Fig. 1) and *trans* → *cis* (Fig. 2). Initial mol. fraction of olefine = 0·091 in each case

The ceiling temperatures of the *cis* and *trans* butene-2 polymerization reactions at the same mol. fraction of olefine (0·091) are 35·7° and 32·5° C., and are independent of the nature and rate of the initiation process. Above about 25° C. both reactions are accompanied by measurable isomerization, the rate of which increases rapidly with temperature. Above the ceiling temperature for polymerization, the isomerization occurs rapidly and is, of course, unaccompanied by formation of high polymer; but no isomerization takes place if sulphur dioxide is absent or if, with sulphur dioxide present, the polymerization catalyst is absent or the system is not illuminated. The theoretical predictions would thus appear to be substantially borne out in practice; but, as will be shown elsewhere, when the full details of methods and results are published, there are reasons for believing that the polymer radical formed from *cis* butene-2 may not be precisely identical in stereochemistry with that formed from *trans* butene-2. This restriction introduces only a minor alteration to the theory represented by equation (4).

We are greatly indebted to Dr. K. J. Ivin for frequent discussions, and to the Department of Scientific and Industrial Research and the Anglo-Iranian Oil Co. for financial aid. [May 16.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Fine Structure in Polyethylene Terephthalate Fibres

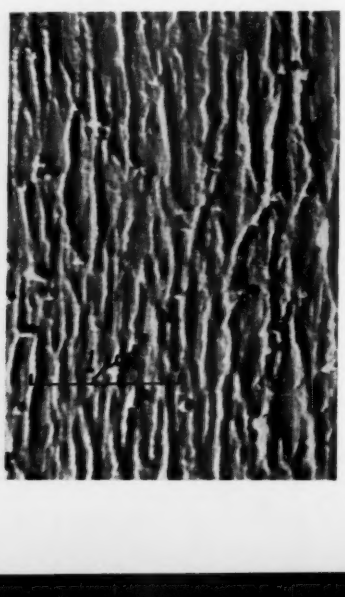
It has recently been shown by Kassenbeck[1] that drawn fibres of polyethylene terephthalate possess a surface skin, some 2500 A. in thickness. This was demonstrated by making two-stage polystyrene–silica replicas of carefully prepared sections, and photographing the replicas in the electron microscope. Kassenbeck also found that a replica taken from a region of a fibre from which the skin had been fortuitously removed revealed an unmistakable fine structure of oriented fibrils[2]. The apparent diameter of these fibrils varied between about 250 A. and 750 A.

It seemed to us desirable to follow up this work, and in particular to devise a reproducible technique for exposing the internal fine structure of drawn monofilaments. Working with comparatively thick monofilaments (0·25 mm. or more in diameter) we have succeeded in doing so.

The method consists simply in tearing open the monofilament down its length. It was thought at first that artefacts introduced by tearing might obscure the fundamental structural features of the specimen, but all the internal evidence suggests strongly that this does not happen. The structure dictates the direction which the tearing shall take, guiding it along planes of comparatively low cohesive strength, and thus the structure is revealed rather than obliterated.

For replication of the exposed surface, we used the evaporation technique, with germanium as the replicating medium. The evaporation method is simpler than that employing polystyrene and silica, as it involves only one stage: and germanium has the advantage over most of the more common replica metals that it yields completely amorphous films and does not tend to crystallize in the electron beam[3].

The accompanying photograph shows the structure revealed by this method in a drawn polyethylene terephthalate fibre. There can be little doubt of its essentially fibrillar character. The diameters of the fibrils appear to lie between about 200 A. and 1000 A., and there are several of the larger fibrils which seem to be built up of those of diameter about 200 A. This suggests that the 200-A. fibrils might be the fundamental ones, and also that there might be an upper limit, indicated by the 1000-A. fibrils, to the extent to which the fundamental fibrils can conveniently group together.



It must be pointed out that any replica technique inevitably introduces some uncertainties regarding the absolute dimensions of the original, and the figures quoted above are therefore only approximate. The results so far obtained are of qualitative, rather than quantitative, significance.

We wish to acknowledge our indebtedness to Dr. P. Kassenbeck for his generosity in discussing his results with us prior to publication. It was as a direct result of this that we turned our attention to the internal, rather than the external, structure of polyethylene terephthalate fibres. We also wish to express our thanks to Imperial Chemical Industries, Ltd., for permission to publish these results.

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Resistant Membranes from Wool and Hair Fibres

In an investigation of the histological structure of wool and hair fibres, we have used the following technique in the preparation of sections for electron microscope examination. Sections 0·4–2·0 μ in thickness were cut of peracetic acid-treated fibres, embedded in ester wax[1]. The ribbons were transferred to water containing a little ethoxy-ethyl alcohol on a microscope slide; the slide was dried at 35° C., and the wax removed with hot xylene. The sections were treated with sodium hydroxide solution for 5–10 min., and the slide was then washed carefully with distilled water, dried, and flooded with a 0·3 per cent solution of nitrocellulose in amyl acetate. The treated sections were then stripped from the slide on the nitrocellulose support, collected and examined.

Fig. 1 is an optical micrograph of a transverse section (stained with methylene blue) of peracetic acid-treated wool after 10 min. in 2N sodium hydroxide solution. The boundaries of the cortical cells, the nuclei of the cells, and some fibrils were resistant to the treatment. Fig. 2 is an electron micrograph of a transverse section of peracetic acid-treated wool after treatment for 5 min. with sodium hydroxide solution. From the electron micrograph it can be seen that the resistant boundaries of the cortical cells are very thin membranes which have fallen on their sides. The membranes are creased and have some fibrils adhering to them. The examination of shadowed specimens has shown that the membranes are of the same order of thickness as

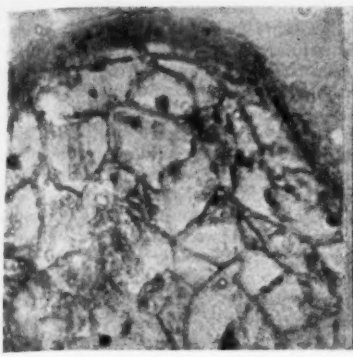

Fig. 1

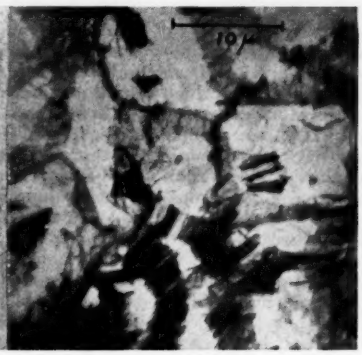

Fig. 2

Fig. 1. Photomicrograph of a transverse section of peracetic acid-treated wool fibre after 10 min. in 2 *N* sodium hydroxide solution; stained with methylene blue. × 800

Fig. 2. Electron micrograph of a transverse section of peracetic acid-treated wool fibre after 5 min. in sodium hydroxide solution

the epicuticle[2], *c.* 100 A. We have observed similar membranes on electron micrographs of sections of hair from a cow's tail and rat's hair which had been given the same treatment.

Peptic digestion of sections of peracetic acid-treated fibres, and the action of 1 per cent sodium sulphide solution at 60° C. for 3 hr. on untreated fibre sections also isolated these membranes.

We wish to thank Dr. R. L. Elliott and Dr. F. Happey for their interest, the Bradford Dyers' Association, Ltd., for a fellowship (to B. M.), and the Wool Textile Research Council for a scholarship (to M. S. M.). A more detailed account of this work will be published elsewhere.

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Degree of Polymerization of Deoxyribonucleic Acid

The improvement of methods for isolating cell nuclei requires the establishment of suitable criteria of nuclear intactness which may be used to evaluate changes in technique[1]. The following experiments were performed in the course of an effort to devise methods for following changes in the degree of polymerization of deoxyribonucleic acid during nuclear isolation.

The physical properties of purified deoxyribonucleic acid vary widely, depending on the preparative techniques employed[2–4]. Poor reproducibility of viscosity measurements has been obtained on duplicate preparations from the same material[5].

A number of investigators have shown that the viscosity of deoxyribonucleoprotein solutions in strong saline is characteristic of deoxyribonucleic acid and is relatively uninfluenced by the proteins present[2,6]. In the hope of establishing a reference value for the viscosity of deoxyribonucleic acid which might be characteristic of the degree of polymerization of this substance in living cells, homogenates were rapidly prepared in cold 0·14 *M* sodium chloride and then mixed with strong salt solutions to dissociate the deoxyribonucleic acid from the proteins present and to give the characteristic viscosity.

Purified highly polymerized deoxyribonucleic acid has generally been studied in concentrations of about 0·2 per cent. However, when rat thymus was prepared so that the concentration of deoxyribonucleic acid was approximately 0·2 per cent after dilution with strong saline, the observed viscosity was so high that the solutions could not be pipetted. In order to get reasonable viscosities, thymus homogenates were prepared in concentrations of 1–2 per cent (wet weight/vol.) in 0·14 *M* sodium chloride and strained through bolting silk. Generally, 5-ml. aliquots were rapidly mixed with 10 ml. of 1·5 *M* sodium chloride to give viscous solutions containing about 50–100 μgm. of deoxyribonucleic acid per ml. as measured with diphenylamine. Other dilutions have also been studied. Viscosities were measured in size 200 Ostwald–Cannon–Fenske viscometers at 25° C. and are expressed as relative to controls pre-treated with crystalline deoxyribonuclease.

Fig. 1 shows the results obtained with thymus homogenates prepared in several concentrations from ten rats. Since the viscosities in all preparations increased on standing, the values used are the averages of a series of determinations made at regular intervals. It is noteworthy that solutions containing only 0·3–0·7 per cent wet thymus tissue (0·005–0·01 per cent deoxyribonucleic acid) have viscosities of the same order of magnitude as has been reported for 0·1–0·3 per cent solutions of purified deoxyribonucleic acid. The results obtained here suggest that reproducible results may be obtained using this method.

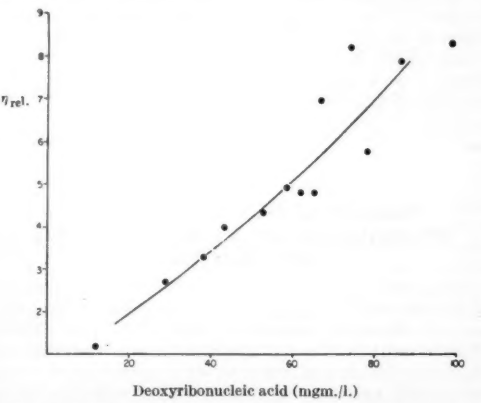

Fig. 1. Viscosity of thymus homogenates in 1 *M* sodium chloride. Viscosity is expressed as relative to control treated with deoxyribonuclease

Trypsin, chymotrypsin and urea (4 *M*) were all found to *increase* the observed viscosity, possibly by releasing a small additional amount of deoxyribonucleic acid. Further studies with preparations from kidney, spleen, liver and brain gave values which were similar for similar concentrations of deoxyribonucleic acid and were all slightly higher than thymus preparations. Within the limits of the technique used, the degree of polymerization of deoxyribonucleic acid in somatic tissues (except thymus) appears to be rather constant.

These observations are compatible with the view that the native substance exists in the form of extremely long chain polymers which are very easily broken. Thus, in the absence of salts, the high mutual repulsion along the molecule together with local fluctuations in thermal energy are thought to cause rapid spontaneous depolymerization. This is believed to account for the low molecular weights of preparations made with solutions of low ionic strength[4]. Treatment of a highly viscous fresh preparation in the cold with the Waring blendor for as short a time as 5 sec. causes an almost complete irreversible loss of viscosity. It is suggested that the purified 'highly polymerized' deoxyribonucleic acid, which appears to have a molecular weight[7] of $1–1·3 \times 10^6$, represents the *stable chain-length* capable of surviving the isolation procedure. The intact molecule is believed to be longer by some factor which cannot be evaluated as yet but which may be as high as 20. It is considered unlikely that an increase in polymerization takes place during preparation, since the homogenates were maintained at low temperature, were mixed with strong saline within 5–10 min. after the death of the animal, and produced a high viscosity within 2–3 sec. after mixing.

These experiments will be described in detail elsewhere; they were carried out under Contract No. W-7405-eng-26 for the Atomic Energy Commission. I acknowledge the technical assistance of Mary Lloyd Anderson.

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Presence of 2-Carboxy-pyrrole in Mucoproteins and its Relation to the Viral Enzyme

2-CARBOXY-PYRROLE has been found as a hitherto unidentified component of mucoproteins. The presence of this component suggested itself from Odin's observation[1] that many influenza virus hæmagglutinin inhibitory mucins produce a purple colour, even without alkali pretreatment, on heating with the *p*-dimethylaminobenzaldehyde reagent. His findings have been extended to the prosthetic group of the pure inhibitory urine mucoprotein[2], the homogeneous inhibitory mucoproteins from human saliva[3], bovine and sheep submaxillary glands[4], the non-inhibitory pure mucoprotein from human plasma[5], the non-inhibitory ovomucoid[6] and the proteins casein and ox-serum albumin.

Authentic 2-carboxy-pyrrole was synthesized according to Oddo[7]. Bovine submaxillary mucoprotein served as a source of the compound reacting directly with *p*-dimethylaminobenzaldehyde. The compound was separated from the protein by mild hydrolysis with barium hydroxide and extracted with absolute alcohol. Its identity with 2-carboxy-pyrrole was shown by the following comparisons. (1) Both gave very similar purple colours with *p*-dimethylaminobenzaldehyde instantly in the cold, and for both the ninhydrin and Molisch reactions were negative. (2) Paper chromatography, using phenol, phenol/ammonia, butanol/acetic acid, *s*-collidine and butanol/pyridine/water as solvents and Ehrlich reagent as spray, revealed identical R_F values and colour shade for both substances. The R_F values in above order were 0·78, 0·64, 0·93, 0·42 and 0·61 respectively. (3) Reduction of the material with Adam's catalyst and hydrogen yielded a substance which coincided with DL-proline in R_F value and colour when run in the solvents mentioned using isatin as spraying agent.

2-Carboxy-pyrrole, ninhydrin-negative and unstable to acid, cannot be the ninhydrin-positive amino-acid of Minagawa[8].

It has been previously shown[9] that in the compound liberated from an inhibitory mucoprotein by the viral enzyme a non-amino-sugar is present; further, Odin's observation[1] that this compound reacts directly with *p*-dimethylaminobenzaldehyde was confirmed.

It is suggested that in the prosthetic group of an inhibitory mucoprotein the carbonyl carbon of 2-carboxy-pyrrole forms an amide link with the nitrogen of an adjacent hexosamine, whereas the pyrrole nitrogen engages in a glycosidic linkage with a sugar residue. Both such linkages would be alkali-labile, as they were indeed found to be. The pyrrole nitrogen has no basic property; hence, if the viral enzyme be an amidase, its action on the link mentioned will add a positive charge to the residual mucoprotein not counterbalanced by an equivalent loss in the split product. In fact, it has been recently found[10] by electrophoretic studies that the net negative charge of the inhibitory mucoprotein sharply decreases after virus treatment. Thus the new data necessitated re-interpretation of some earlier findings[9].

I wish to thank Dr. K. H. Pausacker, University of Melbourne, for valuable advice, and Dr. R. J. Winzler, Los Angeles, for a generous gift of the homogeneous mucoprotein from human plasma.

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Nucleotide Analysis on the Cyto-Scale

It is now possible to isolate and determine quantitatively the ribonucleic acid from individual nerve cells[1,2]. As ribonucleic acid can no longer be considered to be a tetranucleotide structure, methods for nucleotide analysis are of great interest. Thus, the composition of ribonucleic acid has been found to vary in different organs and even within the cell[3]. It takes a very active part in the different functional phases of the individual cell[4]. A knowledge of its purine–pyrimidine chemistry during these phases could therefore be expected to throw some light on the nature of its action. Existing methods for nucleotide analysis by paper chromatography[5] or ionophoresis[6] require amounts of ribonucleic acid in the range 100–1,000 μgm. For a more sensitive modification of these techniques, a few micrograms suffices[7]. Individual nerve cells contain 200–1,000 pgm. of ribonucleic acid (1 pgm. = 10^{-12} gm.)[2], or about one-millionth of that necessary by these methods. To permit analysis even of these small amounts the following method has been worked out.

A piece of copper silk is treated with alkali in order to produce swelling of its fibres. It is washed with water and immersed in a highly viscous citrate buffer of *p*H 3·6 containing glycerol and glucose. This buffer neither takes up nor gives off water at ordinary room humidity and temperatures, and is of high electrolytic strength. Its viscosity is 1,650 times greater than that of water. After at least 24 hours in this buffer the silk is taken out and the excess moisture removed by centrifugation. A fibre 1–2 cm. in length is stretched out on a quartz slide. Small dabs of paste containing the citrate buffer are smeared on both its ends. The quartz slide is then inverted over a groove in a thick glass slide with the fibre perpendicular to the groove. Hydrolysed ribonucleic acid (1 *N* hydrochloric acid for 1 hr. at 100° C.), from which the hydrochloric acid has been removed, is placed at some point along the fibre with a micropipette directed by a micromanipulator. It is applied slowly and is concentrated through the evaporation of the solvent. The work is controlled microscopically. When a suitable quantity of ribonucleic acid has been applied (100–1,000 pgm.), the chamber formed by the quartz slide and the groove is filled with liquid paraffin. Platinum micro-electrodes are then inserted into the dabs of buffer paste. A direct-current voltage (12 V./mm.) applied for two hours separates the four ultra-violet light-absorbing constituents of ribonucleic acid when the buffer has a viscosity of 1,650 centipoises. Less than 1 mm. of the length of the fibre is required, and several analyses can therefore be made simultaneously. The quartz slide is then removed from the oil chamber and provided with a quartz cover-glass. Liquid paraffin is used as the mounting medium. The fibre is photographed, together with a light-calibrating system, in monochromatic light of 257 and 275 mμ wave-lengths respectively. The plates are investigated photometrically and the absolute amount of each base and nucleotide can be computed.

An ionophoretic separation photographed at the two wave-lengths is shown in Fig. 1.

The method is a million times more sensitive than the conventional ones, and permits nucleotide analysis of individual cells.

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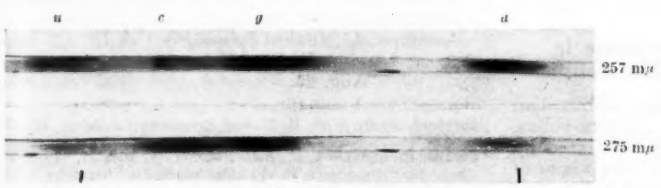

Fig. 1. A separation on a copper silk fibre of 15 μ diameter photographed at 257 mμ (upper) and 275 mμ (lower); *a*, *g*, *c* and *u* denote adenine, guanine, cytidylic and uridylic acid respectively

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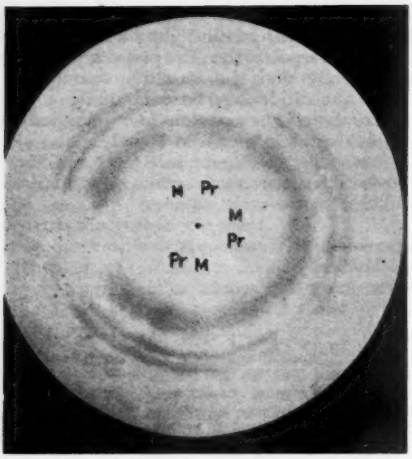
Identification of Amino-Acids Present in Purified Prothrombin by Circular Paper Chromatography

Seegers *et al.*[1] have very recently made an analysis on the amino-acid content, particularly tyrosine and tryptophan, of purified prothrombin. They have also shown by electrophoresis that their prothrombin preparation contains approximately 90 per cent of the protein in one component[1]. Several other workers[2–4] have investigated the nature of the protein in prothrombin. Astrup and Darling[4] have reported prothrombin to be a protein of globulin character. But the complete analysis of the prothrombin molecule with respect to different amino-acid contents is lacking.

In the present communication, the amino-acid composition of the purified prothrombin molecule has been determined by the circular paper chromatographic technique mainly developed by Giri and Rao[5].

Prothrombin was prepared from ox-blood by the method of Seegers *et al.*[6], and the activity of the prepared prothrombin found to be 1,800 units per mgm. protein nitrogen, as determined by the method of Ware *et al.*[7]. The nitrogen content of the preparation was found to be 13·36 per cent (micro-kjeldahl). The hydrolysis of the prothrombin molecule was carried out by autoclaving 100 mgm. of the dried prothrombin in 5 ml. of 6 *N* hydrochloric acid for a period of 6 hr. at 15 lb./sq. in. pressure. Excess hydrochloric acid was removed by vacuum distillation and lastly silver oxide was added to remove the last trace of acid. After filtration the filtrate was used for chromatography.

Chromatography was carried out on Whatman No. 1 filter paper of 18·5 cm. diameter in Petri dishes with solvent mixture containing butanol : acetic acid : water in the ratio of 40 : 10 : 50, the top layer being used. After the completion of the solvent run, the paper was air-dried and sprayed with a solution of 0·1 per cent ninhydrin in acetone and then heated at 60° C. for a period of 10–15 min. Amino-acids were



Circular paper chromatogram of amino-acids present in prothrombin. (*M*), Mixture of known amino-acids; (*Pr*), prothrombin hydrolysate

identified by comparing their positions with those of known amino-acids applied in a state of mixture and run on the same chromatogram. Multiple development[5] was found necessary for the complete separation of all the amino-acids. The following amino-acids have been found to be present in the prothrombin molecule: cystine, arginine, lysine, serine, histidine, aspartic acid, glycine, glutamic acid, threonine, alanine, proline, tyrosine, valine, methionine, phenylalanine and leucines. Tryptophan is also present in prothrombin as determined by us chemically; but it was not found in the chromatogram due to its destruction during acid hydrolysis.

The accompanying photograph shows the chromatographic pattern of the amino-acids identified in prothrombin.

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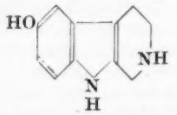
Detection of 5-Hydroxytryptamine in Mammalian Enterochromaffin Cells

It is certainly well known that mammalian enterochromaffin cells acquire a golden-yellow fluorescence after fixation in formalin, as stated by Drs. Shepherd, West and Erspamer[1]. The views of the last author on their content of enteramine (5-hydroxytryptamine), based on his extensive researches into the enterochromaffin systems of Octopoda and Muricidæ as well as Amphibia and Vertebrata, have not been substantiated histochemically, however, and a considerable body of histochemical opinion holds alternative views. According to Cordier and Lison[2], the granules contained an *o*-diphenol with a short side-chain in the *para* position; Lison[3] maintains this opinion. Gomori[4] challenged this view, and concluded that a derivative of resorcinol (*m*-diphenol) was present. Lillie[5], applying his new diazosafranin test, agrees entirely with Gomori.

We are investigating the problem by means of a variety of histochemical and histophysical methods, and our conclusions, so far, support the hypothesis of Erspamer rather than those of Lison or Gomori, which, on the contrary, appear untenable. We have used gelatin solutions of catechol, resorcinol and of 5-hydroxytryptamine, mounted on microscopic slides, both unfixed and after formalin fixation. Formalin-fixed freeze-dried tissue containing the granules (mammalian duodenum) provided the histological controls.

The majority of reactions positive in the granules fail to distinguish catechol or resorcinol from 5-hydroxytryptamine; but the ultra-violet fluorescence is of critical significance. It is positive only in the granules, with unfixed resorcinol, and with fixed 5-hydroxytryptamine. Fixed resorcinols, that is, resorcinol-formaldehyde resins, unfixed 5-hydroxytryptamine and freeze-dried unfixed cells, do not fluoresce. The indole reaction, observed by Erspamer and Boretti[6] to be positive with enteramine, is negative with the granules and positive only with unfixed 5-hydroxytryptamine. It has been repeatedly stressed that the granules are a formalin artefact and, in view of the negative indole reaction in tissue sections, it is pertinent to inquire into the fate of 5-hydroxytryptamine after treatment with formalin. A reasonable explanation of this process is that a harmaline derivative of the type:



is formed. Such compounds do not give the indole reaction, but they are strongly fluorescent. It should prove interesting to compare their fluorescence spectra with those recorded for extracts of human carcinoid (enterochromaffin) tumours by Jacobson[7].

We are endeavouring to show not only that the enterochromaffin granules cannot contain a catechol or a resorcinol derivative and could contain a harmaline derivative, but also that the precursor of the latter is indeed 5-hydroxytryptamine. Work on these lines is proceeding and will be reported elsewhere.

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Detection of Antigen–Antibody Interactions by an Interferometric Method

THE most sensitive technique available for identifying proteins consists of using the protein, by injection into a suitable animal, as an antigen, and diffusing it through a gel containing the antibody produced by the animal. The antigen and antibody combine in certain proportions, and if they are present in sufficient amounts a band of precipitate is formed. Oudin[1] diffused one reactant into a gel in which the other reactant was evenly distributed. Ouchterlony[2] and Elek[3] diffused both components towards one another through a gel. Complex mixtures of antigens and antibodies may be analysed by means of this technique since each specific antigen–antibody system behaves independently as though the others were not present. The principles of the technique outlined below have been described by Ambrose[4] and the technique has been used by Conmar Robinson to examine the diffusion of solvents through polymers[5].

The apparatus consists, essentially, of two glass plates, each optically flat on one surface, which is silvered to give about 5 per cent transmission of light. The two plates with their silvered surfaces facing one another are placed horizontally on a microscope stage, with a cell containing a channel filled with gel between them, and the plates adjusted until they are almost parallel. The plates are illuminated from below with parallel monochromatic light the angle of incidence of which may be varied by means of an adjustable pinhole. Interference fringes are observed, each fringe being a contour line of constant optical path, which with a uniform medium is the path of constant distance between the silvered surfaces. The silver is given permanent protection by a glass plate in the form of a narrow wedge, with its upper surface optically flat, which is cemented to the silvered surface. The inclined upper surface of the protecting plate makes the secondary fringes formed by reflexions between it and the silvered surface of the other plate so close together that they do not interfere with the appearance of the main fringes. With suitable plates, a set of straight parallel fringes can be obtained. If in any region there is, for example, an increase in refractive index, the straight fringes will bend towards the apex of the wedge in that region in order to keep the optical path constant, since an increase in refractive index must be compensated by a shorter distance between the plates. Therefore, if there is an accumulation of a complex between an antigen and an antibody in a particular region, and if this results in a change of refractive index, an inflexion in the fringes should occur in which the peak corresponds to the point of equivalence of the antigen and antibody. This has been observed. The quantity of antigen and antibody combined before the commencement of precipitation may be estimated from the area under the peaks and the thickness of the gel, since the values for the refractive indices and specific refractive increments are almost constant for most proteins[6].

Photographs (*a*) and (*b*) show the fringe systems observed in a gel through which diphtheria antigen, *AG*, is diffusing from the left and antibody, *AB*, from the right. In photograph (*a*) a band of precipitate (B_1) has been formed on the right-hand side. In photograph (*b*), taken of the same system at a later stage, the band of precipitate (B_1) observed in photograph (*a*) has increased in width, and peaks in the fringes can be observed running across the channel

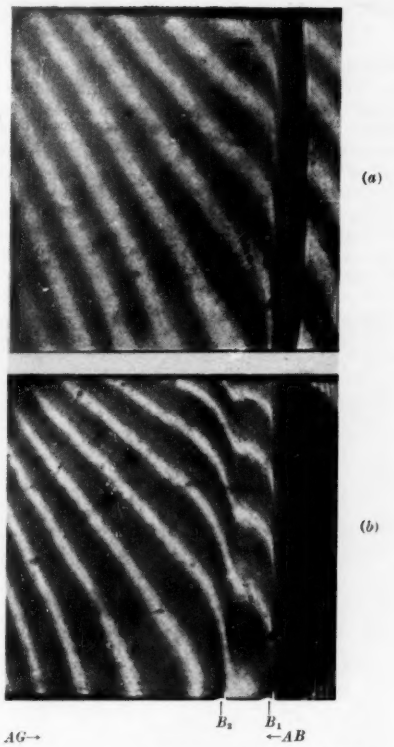

Fig. 1. Interference fringes showing specific precipitation of antigen–antibody complexes in gelatin

to the left of B_1. These peaks (B_2) correspond to the point of equivalence of a second antigen–antibody system. No precipitate at B_2 could be detected when photograph (*b*) was taken. Before any precipitate had appeared in band B_1 it had the same appearance as band B_2 shown in photograph (*b*), giving peaks in the interference fringes, but being quite undetectable by other means.

We wish to thank Prof. A. Haddow and Prof. F. Bergel for their advice and encouragement, and Dr. C. G. Pope for advice and supplies of diphtheria toxin and antitoxin, and also Mr. Menage for making the optical flats.

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Ventricular Nerve Cells in Mammals

Davies *et al.*[1] stated that: "It is widely believed that, in mammals generally, cardiac nerve cells are limited to the atria, extending at the most as far distally as the base of the ventricles near the atrio-ventricular sulcus", and they list an impressive number of orders, including primates, to which this statement applies. They found that only in Artiodactyla and Cetacea were ventricular nerve cells abundant, and they noted that in these the majority of the subepicardial neurons were unipolar or bipolar, with multipolar cells in a minority.

Fig. 1. Bundles of nerve fibres, with several adjacent ganglia, from the subepicardium of the left ventricle of *M. rhesus* (×86: combined intravital and supravital methylene blue)

Fig. 2. Enlarged view (× 326) of one of the ganglia shown in Fig. 1

During investigations into intrinsic visceral innervation, using a combined intravital and supravital technique[2], we have found subepicardial nerve cells both in monkey (*Macacus rhesus*) and rabbit (*Oryctolagus*) material. In the monkey the ganglia were numerous, and those illustrated (Fig. 1) were from a subepicardial area nearer the apex than the atrio-ventricular groove, whereas in the rabbit the cells were scanty. The majority of the neurons are apparently multipolar (Fig. 2), and similar to those occurring in other parasympathetic ganglia. If this is confirmed, the common story that the ventricular supply is entirely or predominantly sympathetic may prove to be incorrect, at least in some primates.

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Quantitative Aspects of the Function of the Sympathico-Adrenal System

In a recent paper from this Department[1] the vascular effects produced by stimulation of sympathetic vasomotor fibres at different frequencies were studied and the 'normal' discharge-range of these fibres during 'resting' conditions and reflex activation of the vasomotor centre was estimated. The conclusion was that normally these fibres fire at very low frequencies (1–2 impulses per second), only exceptionally exceeding 6–8 impulses per second even at strong reflex activation.

Motor effects produced by activity of the sympathetic nervous system are also effected by the suprarenal medullary discharge and, as a third possibility, 'overflow' and consequently 'remote effects' of locally produced adrenergic transmitter substances may occur. In order to get further information about the quantitative role of the direct nervous control, the humoral effects of suprarenal medullary discharge and overflow of the transmitter from sympathetically innervated regions, the following experiments were performed on cats.

The magnitude of the suprarenal medullary discharge, produced by maximal electrical excitation at various frequencies of the nerve fibres running to the glands, was estimated by various biological tests. The effects on the smooth muscles of the nictitating membrane, the iris, the spleen and different vascular regions were quantitatively recorded.

Further, the direct sympathetic innervation of these effector groups was maximally stimulated at various frequencies within the 'physiological' discharge-range, and the responses obtained were quantitatively compared with the effects produced by the discharge from the suprarenal glands and intravenously infused adrenaline and noradrenaline.

Overflow of the adrenergic transmitter, released from a major tissue area, was induced by stimulation at maximal rates of the corresponding sympathetic innervation. The remote effects produced by this overflow were recorded on effector cells, such as the nictitating membrane, either normal or sensitized by

previous denervation. In these experiments, too, the responses obtained were quantitatively compared with the direct effect of the normal sympathetic innervation, the suprarenal medullary discharge and further intravenously administered adrenaline and noradrenaline.

In another series of experiments an intense reflex activation of the sympathico-adrenal system was induced by exposing the animals to controlled asphyxia. The motor responses of different effector groups were recorded as previously mentioned, and the role of the direct sympathetic innervation, the suprarenal medullary discharge and the 'overflow mechanism' was quantitatively analysed.

The results obtained allow the following conclusions :

(1) In the cat the upper limit of catechol secretion from the suprarenal glands, induced by stimulating the nerves running to the glands at maximal physiological frequencies, amounted to, roughly, 5 gamma per minute per kgm. of body-weight, when all the cells were concomitantly activated.

(2) The total amount of transmitter substances released at adrenergic nerve endings seems to be relatively small but, owing to the strictly local release in close contact with the effector cells, very high local concentrations are obtained giving effector responses generally ten or even twenty times bigger than those obtained by the suprarenal medullary discharge, when the glands were activated at similar discharge-rates.

(3) Overflow of the transmitter substances produces remote effects that are still smaller, being only about one-twentieth of the effects of the suprarenal medullary discharge and thus indeed negligible when compared with the effects induced by the direct sympathetic innervation. Further, remote effects can be recorded only on sensitized effector cells and then only at such high stimulation-rates that it seems very doubtful whether functionally significant overflow ever will occur in the intact organism.

It seems justified to propose that, as regards the motor function of the smooth muscle effector groups that are controlled by the sympathetic nervous system, these effector cells are quite dominated by their direct sympathetic innervation. Compared with this direct nervous control the motor effects of the suprarenal medullary discharge are quantitatively of minor importance, while the remote effects of transmitter overflow can be practically neglected. It then follows that, when evaluating the function of the suprarenal medulla, the chief stress must be laid upon the metabolic effects of its hormones, such as the mobilization of glucose from the liver and the lactic acid production in skeletal muscles. Such effects are pronounced even at a rather minute discharge from the suprarenal medulla, whereas they are poorly effectuated by the direct sympathetic innervation of the corresponding tissues.

A full account of this work will be published in *Acta Physiol. Scand.*

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Flight Muscle Autolysis and Reproduction in Aphids

Broadbent[1], working with *Myzus persicae* (Sulzer) and *Brevicoryne brassicae* (L.), showed that there was a greater frequency of flights in batches of 1- to 4-day old alatæ than in batches of older aphids. I have now found that flight in these and other species of aphids is not possible after the first few days from the final ecdysis due to autolysis of the flight muscles. After they have lost the ability to fly the aphids may live for as long as 2–3 weeks, producing 1–4 larvæ per day.

Muscle autolysis may be readily observed by clearing the insects in clove oil, and is first detectable by the separation of the sarcostyles. I have observed it in alate alienicolæ of *Aphis fabae* Scop., *Myzus persicae* (Sulzer), *Brevicoryne brassicae* (L.), *Megoura viciae* Buckton, *Macrosiphoniella sanborni* (Gillette), *Acyrthosiphon pisum* (Harris) and *Macrosiphon euphorbiae* (Thomas).

Autolysis of the flight muscles has now been demonstrated in three widely separated groups of insects : ants[2], mosquitoes[3] and aphids, and it may occur also in some beetles[4]. The nitrogen from the breakdown of the flight muscles of ants and mosquitoes is thought to be utilized for egg production ; muscle autolysis in aphids also appears to be associated with reproduction. Alatæ of *Aphis fabae*, whether they have flown or not, lose the ability to fly after the birth of 12–18 larvæ. These may be born within 2–3 days of the final ecdysis ; but when reproduction was delayed by keeping the aphids off the plants for a few days except for short feeding periods, muscle autolysis was correspondingly delayed. Reproduction and muscle autolysis were also delayed by keeping the aphids on plants in complete darkness from the last larval instar.

Alatæ are economically important in infesting plants and spreading viruses for only a few days before flight is prevented by muscle autolysis. The number of plants that can be infested by a single alate aphid of *Aphis fabae* or similar species before it loses the ability to fly will depend upon the number of larvæ it deposits on successive plants. Aphids depositing only a few larvæ on each of the plants they visit may infest several, whereas those which deposit a large number of larvæ on the first plant on which they alight will be able to infest fewer afterwards.

This work is being continued.

I wish to thank Dr. C. G. Johnson for his many helpful suggestions.

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Phase Coloration in Lepidopterous Larvæ

The occurrence of 'phases' in the larvæ of Lepidoptera has been reported by Faure[1] and by Williams and Long[2]. Field observations have shown that in mass outbreaks of *Persectania ewingi*, the New Zealand armyworm, the larvæ were unusually dark, and this suggested the occurrence of phases in the larvæ of this insect.

This darker coloration has been reproduced in the laboratory by rearing larvæ under crowded conditions. The normal colour of the larvæ is a light reddish-brown, with dark brown or black dorsal stripes and dull red, white or black lateral stripes. The 'gregaria'—larvæ reared under crowded conditions—exhibited a range of colour from dark brown, through to dull black with red and white lateral stripes. The dark colouring became apparent very early in larval life, and third-stage gregaria were quite distinct from third-stage solitaria. These larvæ were reared on grass.

Further larvæ were used as test insects in the development of an artificial food, based on that developed by Beck and Stauffer[3]. There were no differences in colour between gregaria and solitaria. This food contained no pigments.

The theory tentatively suggested to explain these phenomena is based upon the greater activity observed in larvæ kept under crowded conditions. This activity is due not only to competition for food, but also to the tendency towards cannibalism which develops when larvæ are crowded together. It is suggested that there is an increased rate of metabolism consequent upon this greater activity, and that this results in the production of waste products in excess of the amounts which can be excreted. There is thus an accumulation of waste products in the body.

This theory is supported by the above observations if it is assumed that the accumulated waste products of larvæ fed on grass contained grass pigments. The artificial food contained no colouring matter, so that, although waste products accumulated in the bodies of the gregaria, they had no effect on larval colour. Further support is given to this theory by the fact that very dark gregaria, when removed to solitary conditions, slowly reverted to the normal solitaria colour, indicating that there was a steady excretion of waste products from the body under conditions of reduced activity.

Experiments using artificial food containing various pigments will be set up during the coming season. If the theory outlined above is correct, the colour of gregaria should bear some relation to the pigment incorporated in the food.

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Lecithinase Activity of Chloroplasts

The low nitrogen/phosphorus ratio of phospholipids isolated from fresh carrot root or cabbage leaves has been shown to result from the loss of nitrogenous bases by enzymatic action during their isolation[1,2]. A preliminary attempt to extract phospholipids from spinach chloroplasts gave a product with a low nitrogen/phosphorus ratio, suggestive of similar enzymatic degradation. Although lecithinase activity has been investigated in a variety of plants[1-6], the occurrence of lecithinases in chloroplasts has not been reported before.

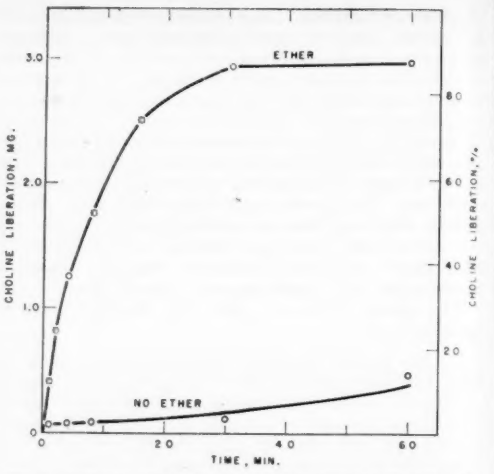

Fig. 1. Influence of diethyl ether on the enzymatic liberation of choline from lecithin by spinach chloroplasts. Reaction mixtures contained 0·5 ml. of 1 *M* acetate buffer (*p*H 4·7), 2·0 ml. of water, 0·5 ml. of 5 per cent lecithin emulsion and 2·0 ml. of chloroplast suspension (2·78 mgm. chlorophyll/ml. suspension), plus 10 ml. of diethyl ether for the 'ether curve'; temperature, 25° C.; reaction was stopped by addition of 0·1 ml. of 3 *N* hydrochloric acid; free choline in the aqueous phase was measured (ref. 8)

Leaf juices were fractionated by high-speed centrifugation[7] into cytoplasm and chloroplast fractions. Their lecithinase activities were measured by determining the formation of free choline[8] and phosphate[9] from pure phosphatidylcholine[10]. Buffered mixtures of chloroplasts and substrate liberated choline very slowly; however, by shaking the mixtures with diethyl ether, the rate of liberation was greatly increased (Fig. 1).

Choline-liberating activity of juices prepared from spinach, sugar beet or cabbage leaves was found to be associated entirely with the chloroplast fractions. The cytoplasm fractions had no activity and were inhibitory. These findings may explain the reported absence of lecithinase activity in spinach press juice[5], which probably corresponds to the cytoplasm fraction. With spinach or sugar beet chloroplasts the optimum *p*H for choline liberation was 4·7 in 0·1 *M* acetate buffer, while with cabbage chloroplasts the optimum was between 5·0 and 5·8 [2]. The choline-liberating activity of spinach chloroplasts was unchanged after 10 min. heating at temperatures up to 40° C., but decreased rapidly at higher temperatures, reaching a negligible value at 70° C. [1,2,5].

The initially rapid liberation of choline from lecithin by spinach chloroplasts (Fig. 1) was accompanied by a much slower liberation of both inorganic and water-soluble organic phosphates[5,6]. Similar formation of phosphates was observed with dipalmitoyl-L-α-glycerophosphoric acid (phosphatidic acid) as substrate. Inorganic phosphate was liberated from L-α-glycerophosphate, but phosphorylcholine and L-α-glycerylphosphorylcholine were unaffected. Thus, the primary step in the degradation of lecithin by chloroplasts appears to be hydrolysis to choline and phosphatidic acid[1,2,5]. Subsequent loss of phosphate and fatty acid from phosphatidic acid may account for most of the inorganic and water-soluble organic phosphate found[5].

Concerning the mechanism of ether activation, the following are noteworthy: (1) The rate of choline

liberation increased rapidly with increase of ether to a maximum at ether-saturation, beyond which the rate remained constant. (2) At or beyond saturation, the lecithin and chloroplast phases were seen to coalesce. (3) Ether-extracted chloroplast suspensions still required the presence of ether for activation; no lecithinase activity appeared in the ether or aqueous phases. (4) Replacement of ether by 'Dreft' or acetone caused some activation, whereas butanol, dioxane, chloroform, petroleum ether, methanol or *n*-butyl ether produced little or no activation.

The finding that diethyl ether activates the lecithinases of chloroplasts supports the explanation given[2] for the origin of the phosphatidic acid isolated after ether extraction of cabbage 'cytoplasm'[11] (which probably contained chloroplasts), and limits the use of this solvent as an extractant for chloroplast phospholipids.

I am grateful to Dr. P. R. Gorham for stimulating discussion and advice, and to Dr. E. Baer for generous gifts of synthetic phosphatidic acid, phosphorylcholine and L-α-glycerylphosphorylcholine.

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A New Method of measuring Oxygen consumed in the Metabolism of Small Animals

The principle of replacing, by means of electrolysis, the oxygen consumed in measurements of metabolism offers the threefold possibility of having a high degree of sensitivity, of controlling the phenomenon for an unlimited time and avoiding calculation entirely. An electrolytic cell (30 per cent sodium hydroxide), capable of producing oxygen, is connected by means of a tube to the thermostatic chamber in which the animal is enclosed. The chamber is provided with a mechanical system for circulating the air and absorbing carbon dioxide, and comprises a pump and a purifier. The whole, including the metabolism chamber, the pump, the purifier, the bell-jar placed over the nickel electrode, and the connecting tubes, is hermetically sealed. Measurement and integration in time of the quantity of electricity supplied by the current generator to the electrolytic cell is done electrically.

The nickel electrode, immersed in the electrolyte, releases oxygen in quantities directly proportional to the electricity passing through it (Faraday's law); for example, 1 gm. atom of oxygen every $2 \times 96{\cdot}540$ coulombs, independently of temperature or pressure.

If the oxygen released by the electrode is not consumed by the animal, it tends to produce excess pressure in the hermetically sealed enclosure in which it is developed. This will cause a decrease in the level of the electrolyte around the electrode and, consequently, a reduction in the area of immersed surface, with a relative curtailment in production of oxygen.

A similar and opposite auto-regulating effect occurs when the consumption of oxygen exceeds the quantity released; the consequent decrease in pressure causes the level of the electrolyte to rise, with a corresponding increase in the production of oxygen.

It is obvious that the rapidity and sensitivity of the system can be varied by regulating the angle of the electrode in relation to the surface of the electrolyte, its shape, nature, the total volume of the enclosure in which the gas is released, and so on. Since the quantity of oxygen released by electrolysis is dependent solely upon the product of current and time (ampere-hour), no error in measurement is brought about by possible fluctuations in voltage at the generator.

The measuring instrument can be readily calibrated in volumes of oxygen consumed by taking into account the electro-chemical equivalent, or in calories. In the latter case 1 litre of oxygen with a respiratory quotient of 0·8 is equivalent to 4·8 kcal., and the current per hour will immediately give the calories per hour consumed by the animal.

Using this method, the average heat production of the albino mouse was found to be 30 kcal./kgm.-hour, and that of the albino rat 15 kcal./kgm.-hour.

Patents on the apparatus are pending.

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Chromosomal Inversions with Sex-limited Effects

For a long time it was thought that the *Drosophila* *X*-chromosomes were genetically very homogeneous. As one-third of the *X*-chromosomes in the populations are carried by the males in haploid condition, the *X*-chromosome genes are much more exposed to natural selection than the autosomic genes. Kerr and Kerr[1] have shown, however, that *D. melanogaster* *X*-chromosomes from natural populations carry a large amount of concealed variability.

The object of the present note is to present further evidence of the presence of *X*-chromosome variability due to gene combinations with sex-limited effects.

In the study of chromosomal variability of natural populations of *D. willistoni* and of *D. paulistorum*, *X*-chromosome inversions were found that present sex-limited effects.

Samples of natural populations of *D. willistoni* and of *D. paulistorum* were obtained from many regions of Brazil. The results of the analysis of these samples may be found in some papers already published[2,3] and in unpublished observations by Prof. Th. Dobzhansky and myself.

Single females of the samples were put in vials with culture medium. The salivary-gland chromosomes of a single F_1 larva from every female of the sample were studied. In two *D. willistoni* samples, those from Monjolinho[3] in the State of Goiaz and from Salvador (unpublished) in the State of Bahia,

Table 1. Frequencies of Homozygotes and Heterozygotes for Two *X*-Chromosome Inversions in Two Brazilian Populations of *D. willistoni* and Two of *D. paulistorum*

Origin of sample and chromosome studied	Homozygotes	Heterozygotes	Total	χ^2
D. willistoni				
Monjolinho	*DD* + *dd*	*Dd*		
XR	11	72	83	44·8
Salvador	*DD* + *dd*	*Dd*		
XL	46	77	123	7·8
D. paulistorum				
Cantareira	*CC* + *cc*	*Cc*		
XL	7	22	29	7·7
Sooretama	*CC* + *cc*	*Cc*		
XL	11	45	56	20·6

and in two *D. paulistorum* samples, those from Cantareira (unpublished) in the State of São Paulo and from Sooretama (unpublished) in the State of Espirito Santo, *X*-chromosome inversion heterozygotes were found with a frequency significantly higher than 50 per cent (see Table 1, where the deviations are calculated taking 50 per cent as the expected frequency of the heterozygotes).

As is well known, in panmictic populations, such as *D. willistoni* and *D. paulistorum* populations, inversion heterozygotes may have frequencies higher than 50 per cent only if the heterozygotes have adaptive values higher than that of both homozygotes.

The data presented in Table 1 show clearly that the *X*-chromosome inversions studied are heterotic. The heterotic value of the *X*-chromosome inversions can be manifested only in the females, the males being haploid for the *X*-chromosome. Genes with sex-limited effects must therefore be responsible for the heterotic value of the heterozygous *X*-chromosome inversions, as has been shown also by Wallace for the 'sex-ratio' gene arrangement in *D. pseudoobscura*[4].

The cytological data here presented show, from an aspect different from that studied by Kerr and Kerr[1], the importance of gene combinations with sex-limited effects in the genetics of natural populations of *Drosophila*.

These data give also further evidence of the adaptive value of chromosomal inversions in *D. willistoni* and in *D. paulistorum*.

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Reconstitution of Virus *X*-Saturated Potato Varieties with Malachite Green

Potato virus *X* is well known as a source of loss to the potato industry, and schemes exist to protect newer varieties from contamination. In most countries there remain in use—often in favour—varieties that are saturated with virus *X*. In Australia the varieties Brownell, Carman and Delaware are in this class. To free such a variety from virus *X* by chemotherapy would be a significant economic advance. It would also be of importance to the general problem of plant virus control by demonstrating that, even with a stable, mosaic-type virus like potato *X*, there is a sufficient difference between the biosynthetic processes of the virus and of the host to make selective chemical therapy a real possibility.

An attack on this problem was made using the potato variety Early Carman. Limasset and Cornuet[1] showed that the content of tobacco mosaic virus steadily decreases as the stem apex is approached, so that the cap of meristem above the leaf rudiments contains very little virus. Takahashi[2] showed that the diaminotriphenylmethane dye, malachite green, strongly inhibited the biosynthesis of tobacco mosaic virus, apparently by enzyme blockage. Assuming that these findings applied equally to virus *X*, the problem was to expose the extreme growing tips of potato stems to the action of malachite green in such a way that maximum inhibition of virus multiplication occurred, but at the same time growth of the stem tip continued, so that the apex might grow away from the virus. It was decided to work aseptically in complete culture solution, and the stock nutrient of Phillip White[3] was chosen. A bacteriologically sterile clone of Early Carman potato was developed by removing a stem apex to agar culture medium and propagating the resultant plantlet vegetatively either on agar in tubes or on filter paper slopes in liquid nutrient. When sufficient material had been developed, stem tips approximately 1 cm. long were added to flasks containing 50 ml. of liquid nutrient plus malachite green at concentrations of 1–4 parts per million, and allowed to float in the nutrient for three weeks. Some growth occurred. The tips of these stems, approximately ½ cm. in length, were then transferred to new liquid nutrient without malachite green to recover and grow for testing by inoculation to *Datura stramonium* or *Gomphrena globosa*. Of the sixteen plants that survived, one plant, from the series containing malachite green at 3×10^{-6}, proved to be free from virus *X*. Others gave a positive test for virus *X* only after some time had elapsed, indicating that the virus *X* content had been reduced by treatment to a very low level. All plants of the untreated control series retained a high content of virus *X*. The malachite green seems to have exerted a true chemotherapeutic effect.

The only instance of successful chemotherapy of a plant virus so far reported is that of peach *X*-disease by Stoddard[4]. This virus showed every evidence of instability. From the number of chemicals that successfully inactivated it *in vivo*—a list including calcium chloride and zinc sulphate—and from the fact that spontaneous recovery occurred among the control plants, one would doubt whether any true chemotherapy was involved. The freeing of potato tissue from virus *X* by malachite green is, to my knowledge, the first instance of successful chemotherapy of a stable mosaic-type virus.

A full account of this work will be published elsewhere.

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Phase Transformation in Uranium

It is well known that pure uranium has three crystalline modifications. The two phases occurring at the lower temperatures are α-uranium, which has an orthorhombic unit cell, containing four atoms[1], and exists from room temperature to 660° C., and β-uranium, which has a tetragonal unit cell, containing thirty atoms[2], and exists in the range 660°–760° C. During an investigation into the crystallography of the β → α phase transformation of uranium chromium alloys at low temperature, the orientation of two α-plates was found relative to that of the β-grain from which they were being precipitated.

The specimen was a piece of 1·4 atomic per cent chromium alloy. This was heated *in vacuo* in the γ-temperature range, cooled slowly into the β-temperature range, and then quenched to retain relatively strain-free polycrystalline β-solid solution[3].

After further heating in an oil-bath at 80° C. for several hours, microscopic examination disclosed that several plates of α-phase had formed in the β-grains, presumably by a martensitic process[4]. One β-grain had in it two well-separated α-plates (Fig. 1), so that it was possible, by using Cahn's microbeam X-ray camera[5], to obtain Laue photographs from the β-grain and both α-plates. Hence the orientations of the grain and plates were found relative to the surface plane of the specimen and a standard direction on the camera stage unit.

Since only a single surface on the specimen was used, the poles of the habit planes of the α-plates could not be identified by a direct method. However, the plane perpendicular to the intersection of a plate with the surface of the specimen must contain the pole of the habit plane of that plate. This plane, normal to the trace of the habit plane, was determined for each plate and plotted as a great circle on the stereographic projection of the α- and β-orientations.

The planes normal to the traces of the habit planes and the orientations of the α-plates relative to a standard (0,0,1) stereographic projection of the β-grain are shown in Fig. 2. This shows that, within the limit of experimental error, the (0,0,1) α-plane is parallel to a {8,1,7} β-plane, and the (0,1,0) α-plane is approximately parallel to a {12,3,4} β-plane. The calculated angle between the (8,1,7) β-planes and the $(\bar{1}2,\bar{3},4)$ β-planes is 89° 28′. It is probable that the orientation of the α-plates relative to the β-grain is not quite the same as that of their original nuclei relative to the same grain, since both phases are deformed as the α-plates grow[4]. However, this orientation difference should not be more than a degree.

Fig. 1. Plates of α-phase formed in a β-crystal. The plates examined are marked α_1 and α_2. Polarized light. × 150

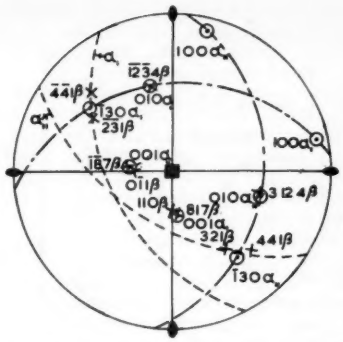

Fig. 2. ■, Pole of (0,0,1) β-plane; ●, pole of {1,0,0} β-planes; ×, pole of other β-planes; ○, pole of α-plane; ——, β-zone; — · — · —, α-zone; – – –, trace normal of habit plane; α_1 and α_2, first and second α-needles

Holden[4] reported that the habit plane for this transformation was the {3,2,1} β. Each plane normal to the trace of a habit plane contains a pole of this type of plane; but accidentally these trace normals are almost equivalent crystallographically, and hence if Holden's result were not known, the pole of the habit plane could be any pole in the trace normals. Such a pole is that of the {4,4,1} β-plane, and it is suspected from measurements on other specimens, where it has not been possible to obtain the orientation of the α-plates, that this may be another habit plane. Neither the {4,4,1} β-plane nor the {3,2,1} β-plane lies parallel to a rational plane in the α-structure; but it is interesting that both lie near a {1,3,0} α-plane, which is a prominent twinning plane for the α-phase[6].

A fuller account of this work will be published elsewhere.

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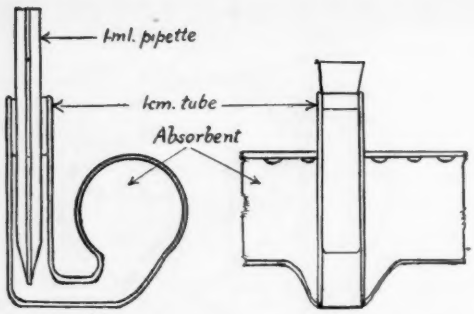
A Modified Pettenkoffer Tube

A modification of the normal Pettenkoffer tube has been developed to save time and materials and at the same time ensure accuracy in the estimation of carbon dioxide evolved during soil respiration experiments. It has also proved of use in the study of the respiration of *Aspergillus niger* in work at this Station by Dr. D. J. D. Nicholas.

This modification allows a 1-ml. sample of the absorbent, usually 0·1 *N* sodium hydroxide, to be withdrawn; hence the absorption of the carbon dioxide can be studied without frequent changing of the sodium hydroxide. The accompanying diagram shows this adaptation; half-way along the length of a normal tube, a second glass tube, *J*-shaped and wide enough to admit a 1-ml. pipette, is joined at its base and arranged at right angles to the main tube, its open end, closed by a rubber bung, lying above the level of the liquid in the main tube.



Modification to Pettenkoffer tube. (a) Transverse section of central portion of tube showing attached *J*-tube modification, with 1-ml. pipette being inserted for sampling. (b) Horizontal view of modification. Stopper inserted and gas bubbling through

A standard method was used as follows: (1) The bubbling of the gas through the sodium hydroxide in the main tube was stopped by means of a screw-down clip. The sodium hydroxide was thoroughly mixed by raising and lowering the tube twice. (2) The rubber bung of the side tube was removed; a 1-ml. sample of the sodium hydroxide was taken and the bung replaced. This sample was added to a standard 15 ml. of barium chloride (30 gm. $BaCl_2.2H_2O$ in 1,000 ml. water) containing one drop of phenolphthalein and immediately titrated against 0·01 *N* sulphuric acid.

It takes 15 min. only to sample and analyse twelve units.

Thanks are due to Mr. G. Jones for the glass blowing involved in the making of the apparatus and the Agricultural Research Council for permission to publish this note.

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Investigation of Travelling Disturbances in the Ionosphere by Continuous-Wave Radio

Observations on the horizontal movements in the *F*-region of the ionosphere by radio methods using the pulse method of ionospheric sounding, and also by employing a precision direction-finding technique, have been made during the past few years[1–7]. The present communication reports the results of recent investigations on travelling disturbances in the ionosphere obtained by a new and simple method in which use has been made of the continuous-wave radio signals from a distant short-wave transmitter.

The investigations were carried out during June–November 1952. Use was made of the continuous-wave transmissions from Madras over a 640-km. path on frequencies of 9,590 kc./s. during afternoons and 4,920 kc./s. during late evenings and nights. Simultaneous observations on oblique-incidence pulse transmissions from Madras were also made during the hours of study to facilitate interpretation of the results. The oblique-incidence pulse observations show that during the afternoon hours, when the transmissions on 9,590 kc./s. are used, only the $1 \times F$ and $2 \times F$ modes are active and are of almost equal intensity, while during the late evening and night higher-order modes up to $5 \times F$ are present on a frequency of 4,920 kc./s., the $1 \times F$ and the $2 \times F$ being much stronger than the other modes.

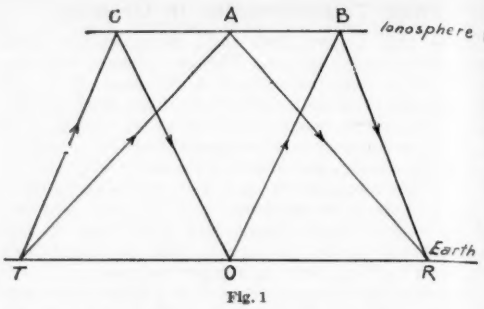

Fig. 1

The principle of the method is as follows. If signals from a distant transmitter arrive at the receiver by way of more than one reflexion at the ionosphere, we have a number of points of reflexion at the ionosphere along the transmitter–receiver path. Taking the simplest case, when the signals arrive by $1 \times F$ and $2 \times F$ modes, there are three equi-spaced points of reflexion in the ionosphere—namely, *B*, *A* and *C*, as shown in Fig. 1. If, then, a disturbance travels horizontally along *BAC* with uniform velocity, its effect on these transmissions will be observed at the receiver on three occasions just when it crosses the points *B*, *A* and *C* in succession. If the size of this irregularity is larger than the distance *BA* or *AC*, the curvature developed in the ionosphere by the disturbance may include two of the points *A*, *B* and *C*, or even all three of them. In either case, the fading record of the received signal will show a Doppler fading similar to the one observed on very high frequencies when an aircraft is moving overhead. This case will be fully discussed in a future communication. When the extent of the curvature is smaller than the distance between any two points of reflexion, it includes only one point of reflexion at a time, and the record of the received signal intensity shows an enhancement due to a focusing effect at the moment it crosses the point in question. Consequently, three equi-spaced peaks will be obtained in the signal intensity record, the spacing between any two successive peaks being equal to x/v, where x is the distance *BA* or *AC* and v the uniform velocity of the disturbance.

The foregoing principle has been applied to deduce the velocities of travelling disturbances in the ionosphere. A typical record illustrating the effect obtained is shown in Fig. 2. Oblique-incidence pulse observations show that, during the hours of study, only the $1 \times F$ and $2 \times F$ modes are active. We may therefore expect three peaks in the record of signal intensity, indicated by arrows, in Fig. 2. From several such records the velocities are deduced to be

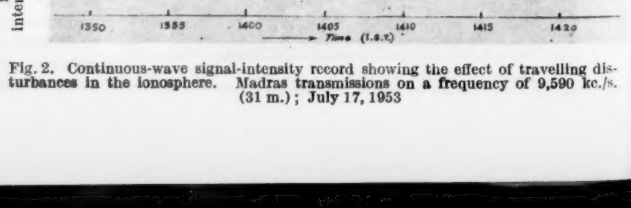

Fig. 2. Continuous-wave signal-intensity record showing the effect of travelling disturbances in the ionosphere. Madras transmissions on a frequency of 9,590 kc./s. (31 m.); July 17, 1953

in the range of 200–400 m./sec., which are consistent with the values of 35–350 m./sec. given by Ross and Bramley[1-3], while Munro's values are 100–200 m./sec. Day-time velocities are found to be higher than those at night. It is observed that the velocity does not remain constant during the day, as revealed by the unequal spacing between the peaks, while it is fairly uniform during the night. Since the $2 \times F$ mode suffers two ionospheric reflexions and one ground reflexion, the presence of this mode gives rise to some scattered signal at the receiver. This makes the peak corresponding to the point C in Fig. 1 appear diffuse. This feature may incidentally be utilized for deducing the direction of travel of the disturbance. In the present case the deduced direction of travel of the disturbance is from north-north-east to south-south-west.

The method has the advantage that the experimental arrangement is simple and inexpensive. A number of recordings have to be made of transmissions from different directions if one wants to study the movements of the disturbances in all directions, thus limiting to some extent the usefulness of the method.

Complete details of these investigations will be published shortly. I wish to thank the Station Engineer, All India Radio, Madras, for his co-operation in arranging the pulse transmissions from Madras.

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[7] Beynon, W. J. G., *Nature*, **162**, 887 (1948).

The method reported by Y. V. Somayajulu[1] for the investigation of horizontal movements of disturbances in the F-layer of the ionosphere utilizes transmissions from a distant short-wave transmitter. We have now evolved a method for a similar study of such travelling disturbances by recording simultaneously the signal-strength of continuous-wave transmissions from two distant short-wave transmitters radiating on frequencies which are very close to each other.

The principle of the method is as follows. When continuous-wave transmissions from two distant short-wave transmitters, arriving at a receiving centre by way of a single-hop reflexion at the ionosphere, are tuned in two communication receivers and the signal-strength variation recorded simultaneously, a travelling disturbance passing over any one of the points of reflexion produces an enhancement of the signal strength due to the focusing effect, and this will be noticed as a prominent peak in the record. If a travelling disturbance passes successively over both the points of reflexion, two almost identical and prominent peaks will be noticed in both the records with a time-difference t equal to the time taken for the disturbance to travel the distance d between the two single-hop reflexion points in the ionosphere. The quotient d/t gives the component of the velocity of the travelling disturbance along the line joining the single-hop reflexion points.

Continuous-wave transmissions from Calcutta and Dacca on the 41-m. band have been used in the present investigation for obtaining simultaneous records of the signal-strength variations of these transmissions received at Waltair during the afternoon, the usual continuous-wave recording equipment being used for this purpose. Light spots reflected from mirrors of the two recording galvanometers trace out the signal-strength variations side by side on the same photographic paper moving with a speed of 14 in./hr. The galvanometers have been suitably damped to eliminate fast-period fading, as the expected similarities are of a long-duration type. Hourly records were taken daily from 1200 to 1300 hr. over a period of two months during May–June 1953. Almost half the records thus obtained showed prominent peaks and curvatures in the Dacca record which reappeared in almost identical form in the Calcutta record after a definite time-interval of 8–13 min. A typical record obtained on June 13 is reproduced in Fig. 1. It can be clearly seen from this record that all the prominences a, b, c and the curvatures between them in the Dacca record, presumably produced by a single travelling disturbance, are reproduced almost identically but with a slight difference in amplitude in the Calcutta record after a constant time interval of 8·5 min., giving a value of 230 m./sec. for the velocity component of the travelling disturbance, the distance between the first-hop reflexion points being 120 km. Except for one or two cases for which high velocities are obtained, the values for the velocity components for most of the records range from 150 to 250 m./sec. Considering the fact that this method gives only the velocity components, which are always higher than the true velocity, it may be seen that these values are in fairly good agreement with the values of 80–160 m./sec. observed by Munro[2] for the actual velocities of travelling disturbances in the F-layer. All the records have shown that the general direction of travel of these disturbances is from Dacca to Calcutta. If we take into account the fact that the directions of travel of these disturbances in the northern and southern hemispheres are opposite, the general southerly movement of these disturbances observed in this investigation is in good agreement with the northerly direction of movement observed by Munro[2] for the months May–June and by Y. V. Somayajulu[1] for the months of June–November.

Simultaneous records obtained on Madras–Mysore and Ceylon–Madras transmissions did not show significant evidence of the presence of these travelling disturbances, probably because these stations have a large separation and are not in a line with the receiving station. The Calcutta–Dacca stations, however, are almost in a line with the receiving site at Waltair and have a comparatively small separation of 240 km. This may be the main reason for the large number of travelling disturbances observed in

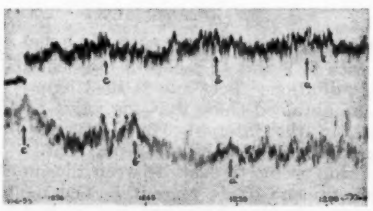

Fig. 1

most of these latter records. In this investigation, although we have ascribed prominent similarities in the records to travelling disturbances, no conclusions can be drawn regarding the nature or type of travelling disturbances in the *F*-layer. Further investigations are in progress with the purpose of extending the usefulness of this method to get full information on the actual wind velocities and directions by simultaneous study of transmissions from three distant transmitters. A full report of these investigations will shortly be published elsewhere.

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July 17.

[1] See preceding communication.
[2] Munro, G. H., *Proc. Roy. Soc.*, A, 202, 208 (1950).

Quantitative Determination of Ethylene Oxide Products in Aqueous Solutions or Dispersions

In recent years, the use of ethylene oxide condensation products as detergents, wetting agents, finishes, and so on, has steadily increased. This makes an analytical method for the determination of such products more and more desirable. In most cases, it is felt, an accuracy of ± 5 per cent is sufficient. The method must be rapid and simple enough for practical purposes.

For a considerable time it has been known that ferrocyanic acid gives addition products with oxygen-containing organic compounds. Starting from this fact, the possibility of using potassium ferrocyanide for the analytical determination of ethylene oxide condensation products was examined. After several modifications the following method was devised.

To a certain volume of the aqueous solution or dispersion of the ethylene oxide product, hydrochloric acid is added while stirring. Then a known quantity (*A*) of potassium ferrocyanide is added.

The flaky precipitate is filtered and the remaining potassium ferrocyanide in the filtrate (*B*) is estimated by titration with zinc sulphate. $A - B$ is the quantity of potassium ferrocyanide consumed by the formation of the precipitate.

For each ethylene oxide condensation product a fixed relation exists between the quantity of potassium ferrocyanide necessary to precipitate a certain amount of ethylene oxide condensation product. This relation (f) can easily be determined using a known quantity of ethylene oxide product. For a solution or dispersion containing an unknown quantity of the same ethylene oxide condensation product (x) it then follows that:

$$x = f\,(A - B).$$

Determinations have been carried out on nonyl phenol condensed with 6, 9 and 12 moles of ethylene oxide in varying dilutions between 0·15–3 gm. per litre. Results obtained show that the value of f for each adduct in the interval 0·6–3 gm. per litre is a constant generally within ± 5 per cent.

A relationship seems to exist between the number of moles of ethylene oxide present in one mole of condensation product and the number of moles of $K_4Fe(CN)_6$ required for precipitation. Thus, in the above-mentioned interval, approximately 0·7, 1·0 and 1·5 moles respectively of $K_4Fe(CN)_6$ were necessary for the precipitation of one mole of nonyl phenol condensed with 6, 9 and 12 moles respectively of ethylene oxide.

Investigations on this subject, especially with regard to its scope, are being continued, and a detailed description of the method, together with results obtained, will be published at a later date.

The interest of Mr. H. Grunewald and the helpful assistance of Miss Birgitta Andersson and Miss Marianne Dahlström in carrying out the experiments are acknowledged.

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July 6.

A New Synthesis of Carbazoles

It has been observed that upon attempted distillation of the oxime of 2-phenylcyclohept-2-enone in a high vacuum, thermal cyclization takes place with the formation of cycloheptenoindole[1]. If the generality of this reaction could be demonstrated, a valuable new route would be available towards obtaining certain natural products containing the indole nucleus, employing starting materials more readily available than those containing a preformed indole system. We wish to report the extension of the thermal cyclization reaction of oximes to a number of new cases.

Thermal cyclization of the oxime of 2-phenylcyclohexanone yielded 1,2,3,4-tetrahydrocarbazole, m.p. 124–125° (from aqueous ethanol). Admixture with an authentic sample prepared from cyclohexanone phenylhydrazone showed no melting point depression. The infra-red spectra of both specimens were identical.

Similar treatment of the oxime of 2-phenylcyclohex-2-enone yielded carbazole, m.p. and mixed m.p. upon admixture with an authentic specimen, 242°. The infra-red spectra of both specimens were identical.

Thermal treatment of the oxime of 2-(2′,3′-dimethoxyphenyl)cyclohex-2-enone yielded 1,2-dimethoxycarbazole, m.p. 134° (from ethanol). (Anal. calc. for $C_{14}H_{13}O_2N$: C, 74·0; H, 5·8; OCH_3, 27·3 per cent. Found: C, 73·7; H, 6·0; OCH_3, 27·6 per cent.)

Similar treatment of the oxime of 2-(2′,3′-dimethoxyphenol)cyclohexanone yielded 1,2,3,4-tetrahydro-5,6-dimethoxycarbazole as a viscous oil, b.p. 180° (2 mm.). (Anal. calc. for $C_{14}H_{17}O_2N$: OCH_3, 26·8 per cent. Found: OCH_3, 27·1 per cent.) Treatment of the oil with palladium–charcoal in boiling cymene gave 1,2-dimethoxycarbazole identical with the product obtained above.

This novel cyclization reaction appears to involve the direct attack of the oxime nitrogen atom on an aromatic nucleus. The reaction is being extended to other systems, and its mechanism is being investigated.

Alfred Löffler
David Ginsburg

Daniel Sieff Research Institute,
Weizmann Institute of Science,
Rehovoth, Israel.
July 13.

[1] Ginsburg, D., and Pappo, R., *J. Amer. Chem. Soc.*, 75, 1094 (1953).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, November 2

BRITISH OCCUPATIONAL HYGIENE SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 11 a.m.—First Conference.

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. A. J. Harris: "Prestressed Concrete in Civil Engineering Works".

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION and FOOD GROUP (in the Chemical Society's Rooms, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Mr. A. G. Ward: "Recent Advances in Gelatin Research".

Tuesday, November 3

ARTHUR STANLEY EDDINGTON MEMORIAL TRUST (at the Arts' School, Bene't Street, Cambridge), at 5.30 p.m.—Prof. H. H. Price: "Some Aspects of the Conflict between Science and Religion" (Eddington Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Discussion on "Standardized Protective Transformers from the Point of View of Maker and User".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 6 p.m.—Mr. N. Tinbergen: "Social Life of Animals". (Further Lectures on November 10, 17 and 24.)

Tuesday, November 3—Thursday, November 5

MINISTRY OF AGRICULTURE AND FISHERIES (in conjunction with the AGRICULTURAL RESEARCH COUNCIL, the NATIONAL FARMERS' UNION, the BRITISH AGRICULTURAL CONTRACTORS ASSOCIATION, and the ASSOCIATION OF BRITISH INSECTICIDE MANUFACTURERS, at the St. George's and Norfolk Hotels, Cliftonville, Margate)—National Weed Control Conference.

Wednesday, November 4

PHYSICAL SOCIETY, COLOUR GROUP (in the Lecture Theatre, Institute of Ophthalmology, Judd Street, London, W.C.1), at 3.30 p.m.—Dr. W. A. H. Rushton, F.R.S.: "Chemical and Nervous Factors in Scotopic Dark Adaptation"; Dr. R. A. Weale: "Some Properties of the Cat's Eye".

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

PRESENTATION OF TECHNICAL INFORMATION DISCUSSION GROUP (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 6 p.m.—Mr. M. G. Scroggie: "Problems of Technical Authorship".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Scientific Papers.

PHARMACEUTICAL SOCIETY OF GREAT BRITAIN (at 17 Bloomsbury Square, London, W.C.1), at 7.30 p.m.—Mr. T. C. Denston: "General Survey of the British Pharmacopoeia 1953".

Thursday, November 5

UNIVERSITY COLLEGE, LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. K. Lonsdale, F.R.S.: "Crystallography, Ancient and Modern".*

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Dr. K. M. Smith, F.R.S.: "Some Aspects of the Behaviour of Certain Viruses in their Hosts and of their Development in the Cell" (The Leeuwenhoek Lecture).

MINERALOGICAL SOCIETY (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

INSTITUTE OF FUEL (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. J. Couture: "French Power Resources and their Utilization".*

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Dr. Audrey I. Richards: "Agoraphobia in Anthropology".

UNIVERSITY OF LONDON (at Birkbeck College, Malet Street, London, W.C.1), at 5.30 p.m.—Prof. Joseph Doyle (Dublin): "Polyembryony in Conifers". (Further Lecture on November 6.)*

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 6 p.m.—Dr. R. W. G. Hunt: "The Fundamentals of Colour Reproduction". (Further Lectures on November 12, 19 and 26.)

INSTITUTE OF METALS, LONDON LOCAL SECTION (at the Royal School of Mines, South Kensington, London, S.W.7), at 7 p.m.—Prof. F. A. Forward: "The Preparation and Properties of High Purity Nickel Powder".

CHEMICAL SOCIETY (in the Chemistry Lecture Theatre, Imperial College of Science and Technology, London, S.W.7), at 7.30 p.m.—Dr. A. W. Johnson: "Aromatic Character in Seven-Membered Ring Systems" (Tilden Lecture).

Friday, November 6

INSTITUTE OF PHYSICS, LONDON AND HOME COUNTIES BRANCH (at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Prof. R. E. Peierls, F.R.S.: "Recent Progress on our Knowledge of Fundamental Particles".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. J. H. Schulman: "Molecular Interactions at the Solid/Liquid Interface with Special Reference to Flotation and Solid Stabilized Emulsions".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

DEPUTY COAL SURVEY OFFICER (with good honours degree in chemistry, fuel technology or geology, or equivalent qualification, and preferably with industrial experience and experience in laboratory control) at the Coal Survey Laboratory, Sheffield—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/690 (November 7).

PRINCIPAL and SENIOR SCIENTIFIC OFFICERS (with first- or second-class honours degree in mechanical engineering, with metallurgical experience; or first- or second-class honours degree in metallurgy, with engineering experience), at the Atomic Energy Research Establishment, Harwell, for fundamental studies of nuclear reactor design, involving assessment of metallurgical and materials problems relative to engineering design requirements—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C.529/53A (November 7).

SCIENTIFIC OFFICER (B.Sc., with first- or second-class honours, or equivalent qualifications, with chemistry as the principal subject, and capable of undertaking general silicate analysis, and preferably with specialized experience in investigation of clays and cement-making materials) IN THE MINERAL RESOURCES DIVISION of the Colonial Geological Surveys, London—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.318/53A (November 12).

LECTURERS (2) (with honours degree in electrical engineering, and industrial experience, and preferably with some teaching experience) IN ELECTRICAL ENGINEERING—The Secretary of University Court, The University, Glasgow (November 14).

ASSISTANT IN NATURAL HISTORY—The Secretary, The University, Aberdeen (November 15).

CHIEF ENGINEER OF THE NORTH EASTERN ELECTRICITY BOARD—Chairman of the North Eastern Electricity Board, Carliol House, Newcastle-upon-Tyne 1 (November 16).

JUNIOR FELLOWSHIP IN AERONAUTICAL ENGINEERING—The Registrar, The University, Bristol 8 (November 16).

SENIOR RESEARCH OFFICER or RESEARCH OFFICER (Textile Scientist) (preferably with honours degree in textile science, physics, or some branch of engineering, and with several years experience in the textile industry) IN THE PHYSICS AND ENGINEERING UNIT, Wool Textile Research Laboratory, Commonwealth Scientific and Industrial Research Organization, Sydney, to develop a programme of research into the physical properties of wool fibres or of fibre assemblies or into the physical principles of textile processes—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 465/34 (November 21).

SENIOR LECTURER or LECTURER IN CHEMICAL PATHOLOGY at the University College of the West Indies—The Secretary, Senate Committee on Higher Education in the Colonies, University of London, Senate House, London, W.C.1 (November 23).

SENIOR RESEARCH OFFICER or RESEARCH OFFICER (with honours degree with chemistry as a major subject, or equivalent qualifications, and experience of research in coal tar chemistry) IN THE COAL RESEARCH SECTION, Commonwealth Scientific and Industrial Research Organization, Sydney, Australia, to carry out investigations into the chemistry of coal tar and to supervise the examination of the chemical products of coal carbonization—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2 (November 27).

JUNIOR PHYSICAL AND ORGANIC CHEMISTS (with first- or second-class honours degree in chemistry, and two or three years research experience in physical or organic chemistry) IN THE DEPARTMENT OF SUGAR TECHNOLOGY AND CHEMISTRY, Imperial College of Tropical Agriculture, British West Indies—The Secretary, Imperial College of Tropical Agriculture, 40 Norfolk Street, London, W.C.2 (November 30).

STRUCTURAL ENGINEER to investigate new structural techniques and experimental methods, with special regard to multi-storeyed buildings—Architect, (AR/EK/SEH/1), County Hall, London, S.E.1 (November 30).

LECTURER IN BIOLOGY, and a DEMONSTRATOR IN BIOLOGY (with honours degree with zoology as the principal subject) IN THE DEPARTMENT OF ZOOLOGY AND COMPARATIVE ANATOMY—The Dean, The Medical College, St. Bartholomew's Hospital, London, E.C.1 (December 1).

PROFESSOR OF PHYSICS—The Secretary and Registrar, University College of North Wales, Bangor (December 15).

CHAIR OF MORAL PHILOSOPHY—The Secretary, The University, St. Andrews (December 31).

ASSISTANT AGRICULTURAL ECONOMIST (graduate in economics and/or agriculture) at the School of Agriculture, Sutton Bonington—The Registrar, The University, Nottingham.

ASSISTANT ENGINEERS and ASSISTANT HYDROLOGISTS (with university degree or diploma in civil engineering and at least two years experience on survey, preferably with River Catchment Boards or Irrigation Schemes) in the Department of Hydrological Survey, Uganda, for duties which will include the erection of river and lake gauging stations, the collection and computation of hydrological data, the survey and design of land drainage and investigation schemes—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.139/9/01.

ASSISTANT METEOROLOGIST (with H.S.C. or equivalent in mathematics and physics, and preferably with practical forecasting experience) with the Trinidad Government—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M3B/33526/NF.

BOTANIST (Plant Breeder) (with good honours degree in botany, training in plant breeding, and some knowledge of statistics as applied

to field experiments, and at least two years postgraduate experience) at Rokpur Rice Research Station, Sierra Leone—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.87/15/01.

CHEMIST to assist in laboratory dealing with members' day-to-day production problems—The Printing, Packaging and Allied Trades Research Association, Randalls Road, Leatherhead, Surrey.

COURTAULDS RESEARCH FELLOWS (2) (with first- or upper second-class honours degree in chemistry) IN THE RESEARCH LABORATORY, Maidenhead, for work of a fundamental nature in physical and/or organic chemistry—The Director of Personnel, Courtaulds, Ltd., 16, St. Martin's-le-Grand, London, E.C.1, quoting Ref. No. D.36.

ENGINEERS and PHYSICISTS, Experimental Officer and Assistant Experimental Officer grades, in Royal Naval Scientific Service Experimental Establishments in the London, Portsmouth, Weymouth and Gloucestershire areas, and Scotland—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.247/52A.

GEOLOGIST (with first- or second-class honours degree in geology, and preferably with more than two years postgraduate experience) in Fiji, to assist the Senior Geologist to map, geologically in detail, mineralized areas in the Colony—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE. 105/49/01.

GRADUATE PHYSICIST of ELECTRICAL ENGINEERING for research and development in connexion with industrial process measuring and control instruments—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting "Instruments".

INTERNATIONAL WOOL SECRETARIAT RESEARCH SCHOLAR (with qualifications in physical chemistry) for work on research on the structure of the wool fibre—The Principal, Technical College, Bradford 7.

MICROBIOLOGIST or BIOCHEMIST (with diploma in bacteriology and/or first- or second-class honours degree in biochemistry, and with some microbiological experience) for research on rumen fermentation mechanisms—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire.

PASTURE RESEARCH OFFICER (with university degree in agriculture or botany and preferably with some experience in grassland work) in the Sudan Veterinary Service, for duties which will include preliminary experimental work and supervision of grazing developments and improvement—The Sudan Agent in London, Sudan House, Cleveland Row, St. James's, London, S.W.1, quoting "Pasture Research Officer 2201".

PRINCIPAL SCIENTIFIC OFFICER (geophysicist) (with good honours degree in physics or geology, and several years practical experience of seismic and gravitational prospecting and general knowledge of other methods of geophysical prospecting) for duties initially at London headquarters, Directorate of Colonial Geological Surveys, and later considerable periods in Colonial territories, Ref. A.204/53A; Two SENIOR SCIENTIFIC or SCIENTIFIC OFFICERS (Geologists) (with good honours degree in geology, and experience in field mapping, preferably in Colonial or similar territories) for duties in the Photogeological Section, Directorate of Colonial Geological Surveys, Tolworth, Surrey, Ref. G.273/53A—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting appropriate Ref. No.

PROFESSOR OF AGRONOMY at the Iraq Agricultural College, Baghdad —Royal Iraqi Embassy, 22 Queen's Gate, London, S.W.7.

RESEARCH ASSISTANT (with honours degree in physics, and preferably with experience in vacuum physics) IN THE PHYSICS DEPARTMENT —The Professor of Physics, Physics Research Laboratories, 78 Upper Redlands Road, Reading.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Northern Advisory Council for Further Education. Sixth Annual Report, 1952–53. Pp. 26+1 plate. (Newcastle upon Tyne: Northern Advisory Council for Further Education, 1953.) [278

Scottish Plant Breeding Station. Annual Report (Abridged) to the Annual General Meeting, 23rd July 1953, by the Board of Directors. Pp. 49+2 plates. (Edinburgh: Scottish Society for Research in Plant Breeding, 1953.) [278

British Social Biology Council. Occasional Paper No. 7: Evolution and Christian Belief. Second edition. By Dr. W. H. Thorpe. Pp. 16. (London: British Social Biology Council, 1953.) 1*s.* 3*d.* [278

A Provisional Law Describing the Conditions for the Perpetuation of Tuberculous Infection and the Principles of Contact; with an Appendix on some applications of the foregoing to a Tuberculosis Control Policy. By F. A. Nash. Pp. 5. (Reprinted from "Tubercle," April 1953, Vol. 34, No. 4, pp. 105–109.) [288

Friends of the Lake District. Report and News Letter, August 1953. Pp. 14. (Ulverston: Friends of the Lake District, 1953.) [288

Twelfth Report from the Select Committee on Estimates, together with Proceedings of the Committee of 29th July and the Minutes of Evidence taken before Sub-committee E on 10th June and subsequent days, and Appendices. Session 1952–53. Pp. xxii+173. (273.) (London: H.M. Stationery Office, 1953.) 7*s.* 6*d.* net. [89

Air Ministry: Meteorological Office. Meteorological Reports No. 13: 1000-500-mb Thickness, North America to Europe, 1946–51; Monthly Means and Extremes. Pp. ii+38. (M.O. 535h.) (London: H.M. Stationery Office, 1953.) 2*s.* 6*d.* net. [109

The Nuffield Foundation. Report for the Year ended 31 March 1953. (Eighth Report.) Pp. 109. (London: Nuffield Foundation, 1953.) [109

West African Cacao Research Institute, Tafo, Gold Coast. Annual Report, April 1952 to March 1953. Pp. 39. (London: Crown Agents for the Colonies, 1953.) 5*s.* [109

Department of Scientific and Industrial Research. Road Research Technical Paper No. 27: A Survey of Some Mixing Plants for Asphalt and Coated Macadam. By D. B. Waters. Pp. iv+48. (London: H.M. Stationery Office, 1953.) 2*s.* net. [109

Roses as Flowering Shrubs: a List of Species and Old Fashioned Varieties, including Climbers. Third edition. Compiled by G. S. Thomas. Pp. 76 (16 plates). (Chobham, Woking: T. Hilling and Co., 1953.) [109

Agricultural Research Council. Soil Survey Research Board. Soil Survey of Great Britain: Report No. 5. Pp. iv+27. (London: H.M. Stationery Office, 1953.) 3*s.* net. [109

Other Countries

Istituto di Studi Adriatici. Memorie di Biogeografia Adriatica. Pubblicate con il Contributo del Consiglio Nazionale delle Ricerche. Vol. 2. Pp. iv+286. (Venezia: Istituto di Studi Adriatici, 1953.) [218

Algal Culture: from Laboratory to Pilot Plant. Edited by John S. Burlew (Publication 600). Pp. ix+357. (Washington, D.C.: Carnegie Institution of Washington, 1953.) 1.25 dollars. [218

Bulletin de l'Académie Polonaise des Sciences. Classe Quatrième. Vol. 1: Numéros 1–2. Pp. 68. (Varsovie: l'Académie Polonaise des Sciences, 1953.) 10 zlotys. [218

Bulletin of the Museum of Comparative Zoology at Harvard College. Vol. 110, No. 1: Zoological Results of a Fifth Expedition to East Africa. 1: Mammals from Nyasaland and Tete, with Notes on the Genus *Otomys*. By Barbara Lawrence and Arthur Loveridge. Pp. 80+3 plates. Vol. 110, No. 2: Zoological Results of a Fifth Expedition to East Africa. 2: Birds from Nyasaland and Tete. By J. L. Peters and A. Loveridge. Pp. 87–138+2 plates. (Cambridge, Mass.: Museum of Comparative Zoology at Harvard College, 1953.) [218

Bulletin of the Museum of Comparative Zoology at Harvard College. Vol. 109, No. 1: Notes on Siphonophores, 2: a Revision of the Abylinæ. By Mary Sears. Pp. 119. Vol. 109, No. 2: Report on the McCabe Collection of British Columbian Birds. By J. C. Dickinson, Jr. Pp. 120–209+2 plates. (Cambridge, Mass.: Museum of Comparative Zoology at Harvard College, 1953.) [248

Museum of Comparative Zoology at Harvard College. Breviora. No. 14: Record of a Hermaphroditic Horseshoe Crab, *Limulus Polyphemus* L. By John P. Baptist. Pp. 4. No. 15: Further Notes on the Earthworms of the Arnold Arboretum, Boston. By G. E. Gates. Pp. 9. No. 16: Notes on the Races of *Microtus frontalis* (Duméril, Duméril and Bibron). By Benjamin Shreve. Pp. 6. No. 17: A New Ordovician Trilobite from Florida. By H. B. Whittington. Pp. 7. (Cambridge, Mass.: Museum of Comparative Zoology at Harvard College, 1953.) [248

Latin American Contribution to Scientific Progress. Parasitology (1949–1950). By Prof. Juan Enrique Mackinnon, in collaboration with Prof. Samuel Barnsley Pessôa, Prof. Félix Pifano and Alfonso Trejos. Pp. 287. (Montevideo: UNESCO Science Co-operation Office for Latin America, 1953.) [248

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